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BEAUTY MACHINES:
ART AND TECHNOLOGY IN THE DEVELOPMENT OF PHOTOGRAPHY AND THE SYNTHESIZER

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Technological culture
2006

20312 words

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Synopsis

This thesis examines the relationship between art and technology. There seems to be a certain antinomy between the two, both as notions and in their incarnations. Through looking at the development of two different technologies with intrinsic connections to art, this thesis aims for a better understanding on the subject. In the case studies I analyze the development of photography and the process of synthesizing sounds, both as art and technology. The SCOT theory is used as a framework for the research for several reasons. Both art and technology are dynamic and flexible concepts that are subject to interpretable flexibility. In the paper SCOT concepts are used analyzing art as well as technology to further explore the relationship.

Keywords: Art, technology, society, SCOT, photography, camera, electronic music, synthesizer

Thanks to Geert Somsen.

Your enthusiasm and guiding throughout the process, and especially when I needed it the most, has been truly inspiring.

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1. Introduction

Art and technology can be, and often are, seen as two opposite displays of human productiveness. This is in regard both to how they are produced, and how they are judged. What is appreciated as quality of art differs from how the quality of technology is measured. Art is commonly judged on how it provokes certain feelings, its beauty, and the genius of the artist, while with technology terms like durability, usability and affordability are commonly used when assessing the quality of an artifact.

I want to examine this dichotomy. I believe that there is only a vague distinction between art and technology. After the cult aspect of art vanished with the introduction of reproducible media, this distinction is even harder to grasp. (Benjamin, 1970) In turn, I believe that art and technology are fluctuating, and that they are products of society. I will therefore have to look at people's views in connection to the terms.

I will explore how people's views develop when confronted with new technology and new art. Concurrently, I am interested in following technological and artistic developments in themselves. I want to see what makes an art 'art', and what makes technology 'technology'. With technology, what is relevant is the transition from invention to innovation. I will argue that the same terms can, to an extent, be used interchangeably for art.

The Oxford Dictionary's definitions of the terms offer a clue to the ambiguity:

> ***Art:*** *human creative skill or its application; branch of creative activity concerned with production of imitative and imaginative designs and expression of ideas, esp. in painting; products of this activity; any skill esp.*

> *contrasted with scientific technique or principle; craft or activity requiring imaginative skill; (in pl.) branches of learning (esp. languages, literature, and history) associated with imaginative and creative skill as distinct from technical skills of science; specific ability, knack; cunning, artfulness; trick, stratagem.*
> ***Technology:*** *study or use of the mechanical arts and applied sciences; these subjects collectively.*

By this definition, the term ‘art’ is very vague, but I can draw two clear conclusions: art is either a process utilizing human creative skill or the product of the process itself. It is contrasted with technology and science. The term ‘technology’ on the other hand, is very rigid. I believe the way people use the terms today, has little significance to the artifacts they describe. I also believe that apart from art supposedly being ‘esp. contrasted with scientific technique or principle’ the rest of the definitions can be used interchangeably to an extent. This means that, according to the *Oxford Dictionary*, the only thing that differentiates art and technology is that art is not technology. I am not trying to imply that art and technology is the same, this is just an incentive for further research. But I will get no way with reasoning alone; as a result I will also empirically show how people relate to art and technology. As opinions alter over time, studying development will be more fruitful. Moreover, to catch the opinions at their most malleable state, I will study art and technology in the making.

In the paper I will therefore explore how art and technology are perceived, and how they develop. For this task I have chosen two cases, both cases deal with the nearly parallel development of art and technology: The first is the development of photography in relation to visual arts, the second is the development of the synthesizer in relation to music. The respective technologies enabled new ways of producing art. I will look at both how the technology developed and how the art developed. Because both cases deal with extensive

developments that happened over relatively long time, I will stop at the time when the technology had a common unambiguous meaning. When focusing on the art I will stop when the process was considered an art by the majority. The time frame is important in itself. At the time of the conception of photography, ‘art’ and ‘technology’ had acquired meanings that resemble what we find today. (Williams, 1987, pp. xv–xvi)

1.1.1. Method

To achieve this, I need a framework to guide me in a way that enables me to research technologies in the making, is non-essentialist and addresses actor’s interpretations. *The Social Construction of Technology* (*SCOT*) method captures the importance of the social factors that direct technological development. According to SCOT theory, technology is malleable and perceived differently by different people until the majority has reached a consensus of what the technology is and means to them. One important point of SCOT theory is that the obduracy of artifacts in the way we perceive them today might mislead us into believing that the artifact’s current meaning is due to an intrinsic characteristic of the artifact itself rather than a result of the social construction of the artifact. SCOT argues that an artifact’s meaning is subject to change.

The malleability of an artifact results in interpretable flexibility and newly invented technology will usually be subject to considerable interpretable flexibility. A technological frame is the paradigm that leads to a certain way to perceive an artifact. Relevant social groups consist of actors glued together by a specific technological frame, and are crucial in the display of power that develops the artifact. According to actors’ adherence to a technological frame, they have different degrees of inclusion. An artifact is stabilized when the interpretable flexibility is reduced, this process is called closure. (Bijker, 1995)[1]

1 Because the SCOT theory has underwent several alterations throughout the years, there are sometimes (slightly) different views in earlier books on the subject. I have as a result based most of the SCOT theory on Bijker’s On Bicycles, Bakelite, and Bulbs, rather than older books,

All these notions can be seen as tools to describe technology in a way that avoids a deterministic conclusion. An artifact's development is not a result of the qualities that it has today, but a result of a social shaping that resulted in the way we view it today.

Because I believe that art shares the attributes that are necessary to put it into the technology label, at least one that is as wide open as the one used by SCOT[2] (in comparison with the *Oxford Dictionary's*), I will examine if it is possible to analyze art interchangeably with technology.

1.1.2. Goals

My goal for the outcome of the paper is to illuminate the connection between art and technology through seeing how they interrelate, and how and why the polarization between the two occurs. Both cases are examples of artifacts used in different ways to create art, while the processes can and cannot be art in itself. Because I will be using the SCOT framework, more or less explicitly throughout the process of analyzing the two cases, I should also be in the position to question how SCOT grasps different concepts governing the development of artifacts.

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such as Bijker and Law's Shaping Technology/Building Society and Bijker, Hughes and Pinch's The Social Construction of Technological Systems.

2 'Technology' refers to human activities, as well as to objects. (MacKenzie, & Wajcman, 1985, p.3)

Figure 1: *Photographer* (Collodion photograph) (Website 4)

2. Photography

In this chapter I will look at the development of photography. I will start by giving a brief, linear account of historical events that serve as vantage points for further research. I will prove that although there is a logical thread through these events, there are implicit factors behind that are important to recognize to get a better understanding of why the events took place. I will look at factors that were important for the development of photography as technology, and then I will look at factors that were important during the development of photography as art. I will use SCOT as a guideline and as a framework to explicate these factors when appropriate.

As with history in general, and history of technology in particular, putting exact dates on events, publications and releases can be simple as long as the information is there, but putting an exact date on more elusive notions such as origin, acceptance and closure, is harder, if not to say impossible. I can only therefore convey a somewhat vague discourse on the history of the invention and development of the camera and the field of photography and its relation to art. I will emphasize the parts important for conveying my thesis.

2.1. Brief History

2.1.1. Origins

The art of making images is at least nearly 30 000 years old, first as cave paintings, later to evolve separately and parallel in different regions in the world and with use of multiple materials, techniques and devices.

Leonardo da Vinci (1452-1519) wrote a text on the *camera obscura* in the 1500s and by this time it started to become known by artists who used it to trace images. At this time the camera itself had developed from being more of an observation of a phenomenon, into an artifact - a wooden box, sometimes with a lens fitted into the hole. The lens greatly improved the luminosity inside the chamber. Over the subsequent centuries the design of the camera greatly varied. There were variations in size, materials and in the way lenses and mirrors were used to alter the projected image.

That certain substances, such as silver nitrate, darkened over time, has been known since antiquity, but it was the German physician Johann Heinrich Schulze (1684-1744) who first described the crucial role of light in the process in the early 1700s. By placing different stencils over a paper coated with chalk and silver nitrate he demonstrated how light made the paper outside the stencil darker, while it stayed unchanged underneath. But unable to fix the image, the paper would soon turn all black. It would take nearly a hundred years before the photographic process was further developed.

2.1.2. Release

The first widely credited as to have made the projected image of the camera obscura permanent, was Joseph Nicéphore Niépce (1765-1833). In the early 1800s he was working on transferring motives to litho stones with the aid of the camera obscura and eventually managed to fix an image on a sink plate using an asphalt coating (so-called *bitumen of Judea*). This process demanded an exposure time of about 8 hours in bright sunlight, and the result was mediocre at best.

Louis Jacques Mandé Daguerre (1787-1851), a painter and designer of stage settings for the Paris opera, started experimenting with the photographic process in the early 1820s. After learning about Niépce’s successful attempt at fixing the image of the camera obscura, the two formed a partnership in 1829 and continued to experiment with light sensitive

substances. When Niépce died in 1833, Daguerre continued the research, aided by Niépce's son Isadore. Daguerre changed the process and eventually succeeded in developing photographs that were both highly detailed and also had an acceptable exposure time compared to the eight hours of Niépce's original process. In 1839 Daguerre announced his *Daguerreotype* at the *French Academy of Science*. The patent was acquired by the French government, and in return Daguerre and Niépce's son got a life long pension.

William Henry Fox Talbot (1800-1877) was less fortunate than Daguerre; developing the *photogenic drawing* and the *calotype,* he insisted in keeping his own patent rights and charged users an annual fee for using his inventions. This attitude prevented a more extensive use of his inventions. The calotype, in contrast to the daguerreotype, produced negatives which were easily copied to several positives[3], and later improvements were based on the calotype rather than the more popular daguerreotype.

2.1.3. Developments

Frederic Scott Archer (1813-1857) tried to improve Talbot's process. He invented the *collodion process* in 1852 and with it, the downfall of the popularity of the daguerreotype. Producing negatives, and thus cheap copies, the collodion process also ensured good quality photos and, on contrary to the daguerreotype, *durable* ones. The photographic plate[4] had to be developed straight after the photo was taken which meant that with outdoor photography a portable dark room had to be provided and set up on the premises. Some of the chemicals used for developing photos were poisonous, making the whole process dangerous as well as tedious.

3 This was easily done by photographing the negative

4 The film roll's 'precursor'.

Around 1880 the *dry plate process*[5] was invented which meant that negatives could be stored for much longer before having to be developed. The coating and development process was also made much simpler, enabling an unskilled person to take photos.

In 1888 George Eastman (1854-1932) released the Kodak camera. “In 1900 it was estimated that for each 100 persons passing through the turnstiles at the *Paris Exposition Universelle*, seventeen were armed with portable cameras.” (Scharf, 1983, p.233)

2.2. Analysis of Technology

I have tried to convey a short summary that captures the main anchor points in the early history of photography; a somewhat straight forward story of a kind you might find in encyclopedias and other reference books, where answers seem simple and without any obvious surprises. Naturally, the story is not that straightforward, there are many other factors that set the course of photography we experience the outcome of today. As Geoffrey Batchen states in his book *Burning with Desire,* photography’s “development [was] a nearly random process, not linear, not induced by science.” (Batchen, 1997, p.180) It is impossible to pin point every single factor responsible for influencing the development of photography, I will focus on issues that definitively have resulted in a major impact on the history, and occasionally I might offer suggestions on what might just very well have been crucial issues. This analysis will be guided by the SCOT framework and therefore emphasizing the social aspects of the development of photography. The development of the camera was, along with the technical preconditions, as much a product of social relations, tradition and other human factors as it was of technological and scientific factors.

5 This was also known as the *gelatin process*.

2.2.1. From Pre to Proto-photography

The first thing that might suggest that there are other than scientific and technical factors involved in the development of photography, is the time lapse between the potential technological birth of photography and the actual. Why did it take nearly a hundred years after Schulze's disclosure of the characteristics of certain light sensitive substances before someone was able to use this knowledge to capture the image of the even older camera obscura[6]? And to further tear up the 'logic' of technological 'evolution': Even the *idea* of fixing the images of the camera obscura predates the release of the daguerreotype by more than fifty years. In 1764 the Venetian science and art writer Count Francesco Algarotti's (1712-1764) *Essay on Painting* was published in English. In the essay Algarotti, who according to Aaron Scharf was "highly influential among artists, not only in Italy but in other countries as well" (Scharf,1983,p.22), not only encouraged the use of the camera obscura by artists but also envisioned a portable "picture by the hand of Nature herself" that artists could study at their leisure (p.22). Even though all these factors, with the possible exception of the latter, should be considered prerequisites for photography, I will show that they were not enough, and it is this remaining part(s) of the puzzle I will use the rest of this section to try to elucidate.

First I will briefly go back to two of the three examples I just mentioned, because even though they appear as examples in many texts on the history of photography, their influence is not certain. Schulze's essay remained unpublished; Carl Wilhelm Scheele (1742-1786) completed the work in 1777, and the phenomenon became better known.

6 The original camera, the camera obscura, describes a dark room (camera obscura literally means 'dark room') with a small whole to let the light in. This is a physical phenomenon. An image will be projected where the light beams hit the wall. According to the laws of optics, the image will be completely reversed, both left-right and upside down. The modern camera's precursor was known from antiquity; Euclid used the camera obscura to demonstrate the principles of the straight line of rays of light. In the Middle Ages Arab astronomers used it for observations.

(Frizot, 1998, p.19) In the case of the inspiration from Algarotti's essay, its influence is highly uncertain as it is quite vague in its description of the photographic process.

In retrospect it might seem weird that photography wasn't invented earlier, a view that was shared by Talbot and expressed in the introduction of *The Pencil of Nature* from 1844-46 (it was published in six parts). Talbot had just learned about Thomas Wedgwood (1771-1825) and Sir Humphrey Davy's (1778-1829) experiments with fixing images by the use of light, sometimes using the camera obscura. They did not succeed, to which Talbot's response was that "while therefore due praise should be awarded for them for making the attempt, they have no claim to the actual discovery of any process by which such a picture can really be obtained."(Talbot, 1980, p.35) He goes on to say that "it is remarkable that the failure in this respect appeared so complete, that the subject was soon after abandoned both by themselves and others, and as far as we can find, it was never resumed again." (pp.35-36)

Ever since the 17th century there has been a debate among physicists whether light consists of particles (*Newton*) or waves (*Huygens*). The 19th century was "the golden age" of the wave theory of light with new knowledge and inventions by the physicists Fresnel and Young. This was a factor contributing to the interest in doing research with light and henceforth the idea of fixing images using light. The idea of fixing the image given by the camera obscura arose in the head of several individuals, so-called *proto-photographers.* "The desire to spontaneously fix images on a light sensitive surface was acknowledged by at least 20 different people from 7 different countries between about 1790 and 1839." (Batchen, 1997, p.32)

All this raises yet another question: If people tried and failed with all the technical prerequisites at hand, why and how did someone succeed?

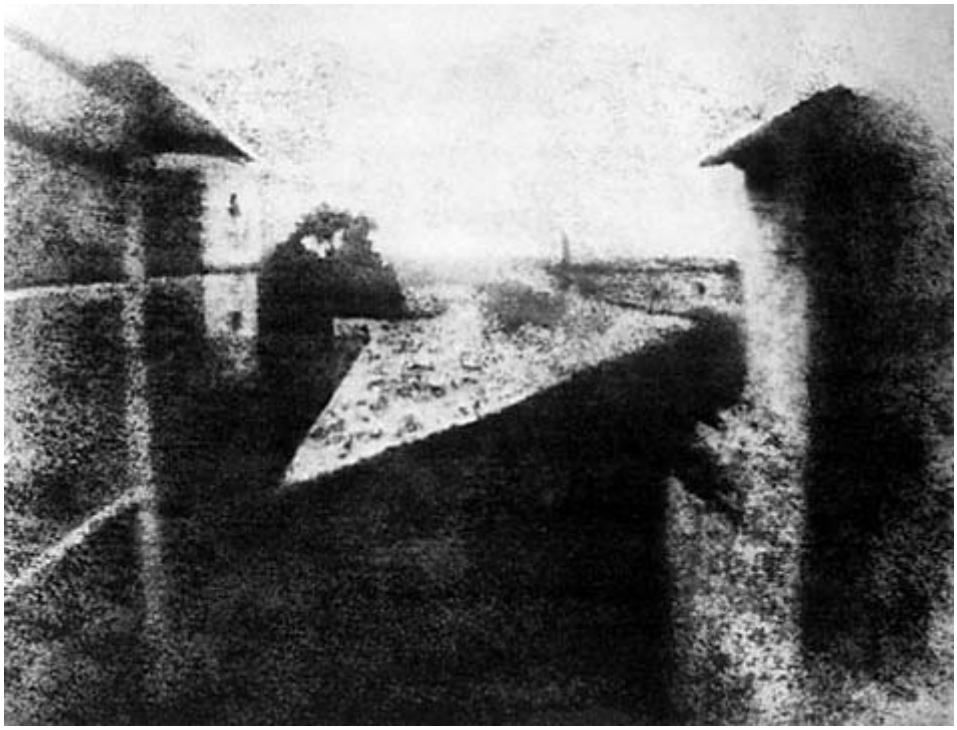

Figure 2: View from the window at Le Gras by Nicéphore Niépce (Heliograph (modern reproduction with enhanced contrast) 1826-27) (Website 5)

2.2.2. Daguerre, Niépce and Talbot

> Louis Jacques Mandé Daguerre: perhaps no other figure in the history of photography is more famous. He did not, it is true, invent photography; no single individual can be given that honor. His invention was founded upon the work of others, and was to be supplanted on the very year of his death by a different technique. Yet it was Daguerre who launched photography. His technique was the first to capture the public's curiosity and imagination. What Wedgwood, Niépce and Fox Talbot had already done would not have come to fruition without the impetus given by Daguerre. Ever the showman, he brought his invention to the public in a way which so excited their interest that photography might be said to have been born on that Monday afternoon in August, 1839, when the French government announced to the crowds that filled the Palace of the Institute in Paris, and to the world at large, the secret process of the daguerreotype. (Newhall, 1971, p.9)

When Daguerre was granted life pension for the invention of the daguerreotype in 1839, he was not the only person to have thought of the concept of permanently fixing the image of the camera obscura. Although not widespread, a few people had already vented their ideas concerning this possibility, and some had experimented but with little success. Niépce was one of the few that eventually succeeded, and although the process needed 8 hours of exposure, he is credited as taking the first photograph. Daguerre was to be the one that succeeded in commercializing the process, and Talbot laid the foundation of the negative/positive based photography we know of today. The three had very different vantage points and incentives for their pursuit of fixing the image of the camera obscura.

Niépce was the first to start experimenting of the three. He was a self-taught engineer, and prior to his research on photography he and his brother had been working on the *pyréleophore*, a combustion engine. Due to his background and the many developments

around that time in ‘drawing machines’, he referred to his research on photography as ‘his latest machine’. (Frizot, 1998, pp.16-18) Niépce and his son Isadore had been practicing lithography for some years when “the elder Niépce, who had little ability for drawing, conceived the idea of recording, photographically, an image on the plate and etching it for printing.” (Scharf, 1983, p.24) This eventually led to two research objectives: Copying existing engravings and fixing the image of nature in the camera obscura, he eventually referred to both as *heliography*. Niépce’s research methods were seemingly influenced by the alchemist tradition, he tried out processes “without following any other logic than the hope of a significant improvement, while freely confessing his ignorance of the subtleties of optics.” (Frizot, 1998, p.20) Accordingly, “Niépce’s merit was to adhere stubbornly to a key idea.” (p.20)

Daguerre, on the other hand, had an artistic background; he had “a considerable reputation as a painter and inventor of illusionist effects in panoramas and, from 1816, as a designer of stage settings for the Paris opera.”(Scharf, 1983, p.24) He experimented with the use of the camera obscura for scenic effects and concurrently the possibility to fix its images on the *diorama*.[7] After learning of Niépce’s efforts and progress on the field, the two met through a mutual acquaintance and eventually formed a partnership in 1829. The partnership was a result of the combination of Niépce’s previous effort and Daguerre’s knowledge of optics and the camera obscura. When Niépce died in 1833, the emphasis on the process turned from the use of asphalt on pewter plates to silvered copper plates.

In October 1833 Talbot, an English amateur artist, mathematician, scientist, and linguist, was trying to make sketches of the landscape around Lake Como in Italy with the aid of the *camera lucida*.[8] He had little success, and as he humbly describes the event, “when the eye was removed from the prism – in which all looked beautiful – I found that

[7] A diorama is a large painting on a transparent surface that is hung up in a way that enables light to shine through from behind. By altering the light source, different visual effects are achievable.
[8] A variation of the camera obscura.

the faithless pencil had only left traces on the paper melancholy to behold." (Trachtenberg, 1980, p.28) He came to the conclusion that using the device for sketching required knowledge of drawing, something he lacked. Even using the camera obscura did not result in a sketch that was "little beyond a mere souvenir of the scene". His failures inspired him to come up with the idea of fixing the image and was careful to write down his thoughts as he reckoned he had had the idea before while day dreaming without paying the proper attention to it. (p.29)

Upon his return to England he started experimenting with silver nitrate, which reaction to light he had read about. But being unacquainted with certain characteristics such as the reaction time (exposure time), he was curious to see if his theory would "prove but a philosophic dream."(p.30) After experimenting with sodium nitrate he came up with a, for him, unexpected solution that managed to fix an image but initially exposure time and picture quality was inadequate. When he later was told by his friend Davy about the sensitivity of the iodide of silver and through experiments realized that it was not the fact, he acknowledged "how little dependence was to be placed on the statements of chemical writers in regard to this particular subject, and how necessary it was to trust nothing but actual experiment". (p.32)

As shown, the three men had a different approach to the process, something which to a degree seems to be based on their background. They were actors adhering to differing technological frames. Niépce's goal differed from the goal of Daguerre and Talbot. So did his process to reach that goal.

When Niépce died, Daguerre could continue unhindered to pursue his goal, to make beautiful positive pictures, which initially were to be made to dazzle the audience of the Paris opera. Niépce's death enabled Daguerre to work, uninterrupted, according this his own technological frame. This background might have been crucial for his success as much of

the later work left for perfecting the process lay in the “mechanism of the light machine” something that Daguerre had extensive knowledge about.[9]

Talbot, on the other hand, was highly educated and had a more theoretical approach to his experiments; although he learned that it was important to be creative and open-minded rather than dogmatic. When Talbot’s inclusion to an academic technological frame diminished, his research progressed because was no longer held by the constraints one a single technological frame.

One thing that is a common denominator between Daguerre and Talbot, is that they both worked toward a similar goal, to quote Scharf, “So, it was that, in the first place, utilizing the discoveries of scientist, photography was invented by artists for the use of artists.” (Scharf, 1983, p.24)

9 A former coworker of Niépce, the engraver Lemaître, had already noted this in a letter to Niépce during an earlier stage of the process: “I believe [Daguerre] to possess a rare intelligence in everything to do with machines and the effects of light.” (Frizot, 1998, p. 21)

Figure 3: *Brand of the hand of Captain J. W. Walker* by Albert S. Southworth and Josiah J. Hawes (Daguerreotype:1845) (Frizot, 1998, p.52)

Figure 4: *Tree* by William H. Fox Talbot (Calotype:ca.1842) (Website 7)

2.2.3. Marketing

Although the three succeeded in fixing the image of the camera obscura, Daguerre is the one that is widely credited for the discovery of photography.[10] Daguerre had tried to sell his invention prior to 1839, but it was likely that he "was dissuaded from trying to sell his invention to private interests … by François Arago, the distinguished scientist and Republican member of the Chamber of Deputies." (Scharf, 1983, p.25) Arago, at the time director of the Paris Observatory, advocated the use of "the machine" (in general, not specifically the camera) and its social advantages in leading society away from barbarism. He convinced Daguerre to hand over the rights to the French government for a life pension in return, and on January 7, 1839 he vented this proposal at the Academy of Sciences. Following that lecture he was set in charge of a report on the proposal, and as a result the daguerreotype was made public on August 19 later that year as a gift to the people from the government. (p.25)

Earlier that year, after hearing about Daguerre's progress, Talbot "soon attempted to secure to his name patents for almost every possible variation and application." (Scharf, 1983, p.31) In return, Daguerre, regardless of the promise to make his invention freely available for everyone, patented the daguerreotype in England and its colonies. This resulted in that, "about a year later, when the initial excitement abated, the strangling effects of both Talbot's and Daguerre's patents were noticeably curtailing the practice of photography in England." (p.31)

The role of Arago in this process seems to have been decisive, not only through his influence and enthusiastic behavior, but also because of his friendship with Daguerre. In

10 There are people who do not see it this way; for example does Marshall McLuhan, in his seminal book Understanding Media – The Extension of Man, continually refer to Talbot as the inventor/discoverer of photography, on the grounds that the positive/negative aspect of the calotype was the crucial discovery and what later developments rested on.

The Pencil of Nature[11], Talbot comes up with two causes for Daguerre's celebrity; the "beauty of the discovery itself" and the "zeal and enthusiasm of Arago" who, "animated by private friendship", convinced the government. (Trachtenberg, 1980, p.35) Another, possibly more objective, example of Arago's influence on the outcome of the process concerns Hippolyte Bayard, and his experimentation with photography. Bayard had been working on the photographic process and had "produced images on paper … at least as early as 5 February 1839." (Scharf, 1983, p.31) He went on to show his results to Arago on May 20 the same year but although he received a 600 franc grant, "his work was suspiciously obscured during the effort to win government support for Daguerre." (p.31)

2.2.4. Scripts and Cultures of Use

Crucial for taking the leap from an ever so marvelous invention to a successful innovation is knowledge of the market. Both Arago and Talbot realized the importance of waiting to release the final "product" until the *time was right*, which meant when they both felt certain crucial characteristics such as exposure time and picture quality were good enough. (Arago, 1980, p.19; Talbot, 1980, p.34) Niépce on the other hand had made an early attempt at releasing his technique but with no success, at least partly due to the technique's shortcomings. At the end of 1838, when unsuccessful with previous attempts to sell his invention, Daguerre "attempted to attract investors … by distributing a printed notice outlining several applications for his methods, including its potential for portraiture – though this was rather premature considering the long exposure times necessary at that

11 The Pencil of Nature, was published by Talbot in six parts between 1844 and 1846, and was supposed to be a showcase of how the calotype could be used. These publications are commonly known as being the first works illustrated with photographs although some argue that Anna Atkins' 1843 book British Algae: Cyanotype Impressions deserve the honour. Deciding who is right is a matter of definition, the illustrations in Atkins' book are photograms rather than photographs, which means the illustrations were not made by a camera. (web rleggat) The long gap between the volumes and the price lead to critique for The Pencil of Nature, exemplified through The Athenaeum review: "…all this proves that the effort required to take a photograph is too great for it to ever become generally useful means of illustrations." (Frizot, 1998, p. 62)

date." (Scharf, 1983, p.25) Arago raised this issue in his report referring to earlier states of Daguerre's work and concluded that "had he [Daguerre] pursued this direction, his pictures would probably be shown in collections as experimental results among the curiosities of physics, but assuredly would never have become a subject for the consideration of this chamber." (Trachtenberg, 1980, p.19) Talbot also resisted the temptation of trying to release his invention after having managed to fix the image of the camera obscura in 1835, because he felt the result lacked essential qualities. (pp.34-35)

In contrast with many newly-introduced technologies where the initial idea of its use differed vastly from what it came to be used for, (in)famously represented by Edison's phonograph and Daimler's combustion engine, the initial views of the use of the modern camera after the introduction of the daguerreotype were quite in accordance with the use of the camera today, with the possible exception of motion picture.[12] Even the fact that the existing technology prevented the camera from becoming something "everyone" could own, due to potential dangerous exposure to chemicals, the limited portability of the camera itself and the metal and glass plates that were used to fix the image on before the introduction of the dry plate process, the French Government exclaimed, after obtaining the daguerreotype patents, that everyone should now be able to use the camera. The French Government was actively enrolling different relevant social groups, convincing them what was to be expected from photography.

The report examining the proposal of the bill granting Daguerre and Niépce jr. a life pension was based on four questions. Apart from the first question which dealt with the originality of the invention, they were concerned with practicality and future use of photography. First of the three questions left was whether photography could be an aid for archeology and fine arts. The report concluded that it could indeed be a service to the fine

12 The phenakistiscope, stroboscope and zoëtrope – "flip-book" devices that utilized drawings or lithographs - were developed prior to the daguerreotype in the early 1830s. (Scharf, p.204)

arts and as for archeology, with an emphasis on Egypt and hieroglyphs, photography would be of great help saving time, workload and money, the latter advantage being something "that seldom go[es] hand in hand in the arts with the perfecting of production." (p.18) As for practicality the report discussed the impracticality of using metal plates, but stated that this was a necessary compromise for the lack of quality in using paper. It continued to praise the ease of use and speed of the process, but acknowledged that there were three problems; the slowness of the process seen as whole, the irreproducibility, and the fragility of the result. The last question inquired whether photography could/would be an advantage for science, and in return the report mentioned the use when measuring luminosity, astronomy and states that most scientific discoveries will yield an unexpected and bigger return, implying that *what we say is promising, but history has shown that reality will dwarf our predictions.* (pp.20-23)

Photography was from early on used in science, especially concerning observations of both the universe and the microscopic world. Major breakthroughs in astronomy in the 19th century, owed their discovery to photography. John Herschel (1792-1871)[13], president of the Royal Astronomical Society, replicated the daguerreotype process only weeks after its public disclosure and proceeded to take the first photograph on glass (of his father's observatory). He continued to make contributions to the process and also coined the words 'photography', 'snapshot', and 'positive' and 'negative' in their photographic context. The process proved a great boon for Herschel and other astronomers especially as they could now compare luminosity of stars with a before lacking objectivity. Photography could also detect objects invisible to the eye because of its ability to gather minute amounts of light during long exposure. There were skeptics though; rightly stating that chemical residue on

13 Son of astronomer William Herschel

the photograph could be misinterpreted as a feature of the night sky. (Singh, 2004, pp.202-03)

The use of photography for documentation in newspapers and magazines was also there from the very start. There was a demand from the public for documentation by images. "There is no doubt that, even at that time, written narratives of events took second place to visual depictions". (Frizot, 1998, p.136) This eventually spelled the death of the engraver who at the time was the traditional person responsible for realistic news images and the reproduction of other works of art. Interestingly it took a few decades for this to happen as the introduction of photography resulted in "...the general increase in the use of an illustrative material" (Scharf, 1983, p.34) and thus offered life support to the profession, albeit a short lived one.

There were also attempts at 'art' photography by photographers such as Julia Margaret Cameron (1815-1879), Charles Lutwidge Dodgson (1832-1898)[14] and Oscar Gustave Rejlander (1813-1875) among others.

Photography was by Arago *scripted*, or set up, for many uses. Because there were so many proclaimed uses for photography it did not develop in a strict path, there was a wide culture of use. The interpretable flexibility of the artifact was not contained by a strict technological frame, hence opportunities for development flourished. (Pinch & Trocco, 2002, p.311; Bijker,1995)

2.2.5. Non Linearity of Technological Evolution

Although the public seemed to know what they wanted the camera to do and which features it lacked and should have, the *technology* of photography did not gradually improve according to the demands. As mentioned, the daguerreotype was from the beginning far

14 Better known as Lewis Carroll, author of Alice in Wonderland.

more popular than the calotype[15], even though the daguerreotype's limitations were acknowledged, and the calotype has proved in retrospect to have laid much of the foundation photography has rested on. It was not until the introduction of the *albumen process*, that the picture quality of the daguerreotype was seriously contended. This process was introduced by Niépce's younger cousin Abel Niépce de Saint-Victor who finally managed to make an emulsion that would stick to a glass plate. This process had its weaknesses. It demanded an exposure time that was much longer than existing processes, relegating the use of albumen coated glass plates to architectural and still life photography.[16]

Around the same time, around 1850, Scott Archer came up with a practical method to use collodion[17] as emulsion on glass plates, and this discovery set stage for a new era of photography.[18] Like the albumen and calotype processes, the collodion process was based on the negative/positive principle which made its photographs easily reproducible. Where the other two lacked essential qualities, the collodion process excelled. Exposure time was greatly reduced; under good conditions it could be as little as 1 second. "Detail was captured far better and there was a greater nuance of light and shade."(Frizot, 1998, p.92) But the process had its drawbacks. The process itself needed a more skilled and better equipped photographer. The glass plate had to remain wet until development; a lot of equipment had to be readily accessible when away from a studio. To make matters worse the glass plates that had to be carried had to be in the same size as the resulting photograph. A technique for

15 This was sometimes referred to as daguerreomania.

16 Although the use of albumen solution for negatives quickly died out, it found another use as coating on paper for the (positive) prints from negative. This practice resulted in an enormous demand for eggs. (Albumen = egg white) Albumen printing paper was widely used until the turn of the 20th century when it was gradually replaced by gelatin paper (Even though some disliked its appearance due to its strong glaze).

17 A product based on gun-cotton which was invented a few years earlier.

18 The use of collodion spawned other processes such as the ambrotype and tintype, the latter being used until at least the 1950s. Both were (as the daguerreotype) direct positive processes, on glass and metal respectively.

enlargement was yet to be introduced, and the 1850s saw an increasing demand from customers for bigger photographs.

Nevertheless, the collodion process proved a watershed in the history of photography. At least two distinctive fads started as a result of the innovation; *stereographic photography* and *carte-de-visite*. Stereography was "a simple device for taking pictures (with two lenses) and for viewing them (with two eye-pieces) thereby creating the illusion of depth". (p.175) As the price of portrait photographs dropped, carte-de-visite photographs, small pocketsize and mass produced photographs, became increasingly popular. "Well over 100,000 copies of … portraits of Queen Victoria were sold in the 1860s. In 1867 300,000 copies were sold of the *carte* portrait of the popular Princess of Wales carrying Princess Louise on her back." (Scharf, 1983, p.42)

The collodion process was constantly improved after its conception, but the first radical and functional improvement must be credited an English medical doctor, Richard L. Maddox (1816-1902), who introduced a "new practical form of dry plates." (Frizot, 1998, p.233) After a few years the process had been perfected to such a degree that the process had an "almost childish simplicity" and permitted "snapshots of 1/25 of a second, an achievement which astounded the photographic community." (p.233) It was also a catalyst for the "commercial exploitation on an industrial scale" (p.233), both Antoine Lumière (1840-1911)[19] and George Eastman moved from workshop to commercial production.

Eastman was one of the pioneers of the dry plate process. During the 1880s his business bloomed; in 1884 it "was changed from a partnership to a $200,000 corporation", in 1886 "Eastman became one of the first American industrialists to employ a full–time research scientist to aid in the commercialization of a flexible, transparent film base", and in

19 One of the Lumiére brothers. They were the inventors of the *cinematograph.*

1888 the company changed its name to Kodak.[20] The same year they released the first Kodak camera with the slogan *"You press the button - we do the rest"*, and it soon became a hit with the public.[21] (Website 1)

As I have shown photography was not a result of linear innovation. The major breakthroughs had often little in common with previous innovations. This would be partly due to the fact that there was no explicit 'photography inventor' technological frame. If we go down a level, to the specific types of processes, the situation is different. One can then talk about a specific technological frame, like for example a 'collodion process' technological frame. Actors within the same technological frame may tend to produce incremental improvements. (Bijker, 1995, p.276) Accordingly, the collodion process was continually improved through incremental developments. To conclude, the photography improved in a non linear fashion, while specific photographic processes improved in a somewhat linear way.

2.2.6. Philosophical ambiguity

Perhaps the best evidence of the pervasiveness of photography in the nineteenth century remains its appropriation by both philosophies [i.e. positive realism and metaphysical romance]; photography's power lay in its potential to be identified either as validation of empiricism in its surface documentation of the world or, conversely, as proof that any visual account inevitably represents the world inadequately. (Green-Lewis, 1996, p.12)

The struggle for defining photography can be seen at least from the time of the proto-photographers. (Batchen, 1997) Niépce described heliography as a process which

20 According to Eastman the name Kodak was chosen after a peculiar criterion, it had to start and end with a K as Eastman thought it was a strong letter. A number of combinations were tried out before the name was settled.

21 Amateur Photographer (after the introduction in Great Britain late 1888) review stated: "We venture to say that it is, without exception, the most beautiful instrument that has ever been offered for the public in connection with photography. "

From the Photographic News Almanac, 1891:

'In my varied wanderings I have met the gentleman with the black leather covered box everywhere.... where the American tourists swarm, the Kodak seems as necessary a part of their belongings as the portmanteau' (Website 2)

"consists in the automatic reproduction, by the action of light, with their graduations of tones from black to white, of the images obtained in the camera obscura." (Niépce, 1980, p.5) People found it very hard to describe what the camera actually did. Was it recording nature? Was it a painting drawn by the sun? Was it nature depicting nature? The philosophical ambiguity of photography was something that was to follow it throughout its infancy. The ontology of photography was used in critique from every angle, it was either this or that or it was *too* this or that. For instance, John Ruskin stated that "photography lacked intrinsic merit because of its inability to be fully truthful." (Scharf, 1983, p.98)

But there was also a less metaphysical issue regarding this, the camera had several distinct and different fields of use, especially with connection to art. A photograph could be art in itself, it could aid a painter, being far more accurate than a sketch, and it could reproduce other works of art. This characteristic is not properly described in SCOT theory because it deals with an artifact that will have several different meanings for the *same person* even if that person is a part of only one relevant (and technologically frame-bound) social group.

2.3. Analysis of Art

> Art's mortal enemy, [photography] was called, and there is abundant literary evidence to indicate that such feelings were widespread. (Scharf, 1983, p.14)

In the previous section I explored how the technology of photography was developed. In this section I will explore photography as art. I will use the same methodology though I will now discuss art rather than technology.

The art of photography was clearly something made possible by the invention of the photographic process, but its influences span wider than just the technology. People's

conceptions about art and aesthetics, the ontological ambiguity of the medium and other social factors were influential in navigating the path.

2.3.1. Initial View on Photography in Connection to Art

Daguerre had the artist in mind when he announced his invention, stating that photography "will also give a new impulse to the arts, and far from damaging those who practice them, it will prove a great boon to them."(Daguerre, 1980, p.12) Arago, head of the commission responsible for examining the proposal of granting Daguerre a pension, based the report on four questions. One of the questions asked whether the invention would "render a valuable service" to the fine arts. The painter Paul Delaroche (1979-1856) was requested to give an expert report to the commission on this issue. In it he praises the "unimaginable precision" of detail and the richness in tone and how the most skilled painter would not be able to reproduce it even after extensive time and labor. Arago's reaction to Delaroche's report: "After having opposed with excellent arguments the opinions of those who imagined that photography would be detrimental to our artists and especially to our engravers, M. Delaroche concludes his report with the remark: 'In short the remarkable invention of M Daguerre is a great service rendered to the Arts.'" (Arago, 1980, p.18) Interestingly, Delaroche only talks about photography as an asset for artists; he does not consider the photographs as works of art in themselves. Both Arago and Daguerre seemed to share this same (implicit) view.

From the very beginning the art community sensed the significance photography would have on the world of art but not its magnitude and scope. The responses were many and varied from fear to praise. One of the earliest criticisms towards the camera, published in *La Caricature*, dealt with how the French government encouraged the machine rather than the genius. But it also reassured artists that photography posed no threat to art, referring to a photograph's lack of colors.

Portrait painting became increasingly popular due to the wealth of the recently established middle class[22], a result of economic growth catalyzed by the industrial revolution. "'Within fifteen days after the publication of the process of M. Daguerre in Paris', recorded one of Daguerre's overenthusiastic pupils, 'people in every quarter were making portraits.'" (Tagg, 1988, p.41) Portrait painters were among the first groups of artists who felt the powerful impact of photography from its very conception, and from early on it was predicted that photography would kill the art of portrait painting.

2.3.2. Repercussions

The technical shortcomings, most notably the incredibly long exposure time needed in the early years of photography, proved the death of portrait painting to be an overly hasty prediction. Initially, the subjects of a photography portrait would have to sit completely still for up to twenty minutes, without moving, in order to have their picture taken. This was reflected in the poses of the subjects as they were often resting their heads on their hands.[23](Scharf, 1983, p.40)

As seen from this, photography's biggest asset was not its less time consuming practice compared with painting, rather the level of details one would get in a photograph. There were different opinions on this issue. Some felt that while a photograph would render the subject more accurately than a painting, it would also lack a painting's potential for showing the essence of the person - *l'esprit humain*, showing the person as they were perceived by the artist, themselves, society, not just a mirror image. (p.141) In 1841, Rodolphe Töpffer (1799-1846) argued that the daguerreotype displayed, quote, "the image of the visible instead of a sign of the invisible." (Quoted in: Frizot, 1998, p.138)

22 'Class' was originally only referring to a division or a group such as school classes. In the late 18th century the word started being used for social classes, first for the lower-class. Social classes had existed previously, but this confirmed a change of attitude towards the issue. (Williams, 1988)

23 In some of Ingres' portrait paintings the subjects are portrayed with this peculiar posture, suggesting that a daguerreotype was used for the painting. (Scharf, 1983, p.50)

Interestingly, a similar view had existed long before the launch of the daguerreotype. In the 1700s William Hogarth (1697-1764) denounced the use of the camera obscura “on the grounds that it subjugated the vision of the artist to the imitation of a lifeless rather than an animated nature.” (Quoted in: Scharf, 1983, p.20)

This issue was reassessed when the collodion process reached popularity.[24] The calotype, which the collodion process to a wide extent replaced, had a similarity with drawing (in fact, the term ‘drawing’ was still widely used for photographs around 1850). (Frizot, 1998, p.96) Some claimed that “photography became *too* detailed”. Lady Elisabeth Eastlake (1809-1893) was one of them: “Far greater detail and precision accordingly appear. Every button is seen – piles of stratified flounces in most accurate drawing are there|, - what was at first only suggestion is now all careful making out, - but the likeness to Rembrandt and Reynolds is gone! There is no mystery in this.” (Eastlake, 1980, p.60)

Others praised the camera as a way of funnelling out the mediocre artists as their skill lay basically in trying to copy nature rather than elevating it past the extent of the (perceived) possibilities of photography. Physicist Sir John Robison (1792-1882) uttered after having witnessed the daguerreotype, quote: “for the eyes accustomed to the accuracy of the daguerreotype pictures, will no longer be satisfied with bad drawing however splendidly it may be coloured.” (Quoted in: Scharf, 1983, p.35)

Eventually the number of portrait painters did plummet, many of them starting new careers as photographers. Landscape painting was another of photography’s unlucky victims. As technological improvements, most notably the dry plate process, vastly improved the photographer’s flexibility when working outside, photography became the

24 “The contribution made by the collodion glass negative, which remained in use for nearly 30 years until about 1880, concerned the very nature of the photographic image. It gave the spectator, looking directly at the subject and actually holding the little viewfinder and framing the entire image, the whole picture, within a proscribed, flat surface. The effects of light, the lively nature of the groups, and the apparently instant nature of the photographic record all combined to give an impression of a palpable reality that was constantly evolving.” (Frizot, 1998, p.101)

primary medium for capturing realistic outdoor images. In 1856 Count de Laborde predicted that photography would replace realist art, and "would be responsible for the return of the art to the 'higher regions of the mind', art's true domain." (Quoted in: Scharf, 1983, p.142) Eventually photography was to instigate the demise of purely imitative art, in the process encouraging conventional art to look beyond the realistic in an attempt to portray something that was not possible - or believed not possible - to portray in a photograph. So, interestingly, while discouraging artists, photography was also a catalyst for expanding the field of painting into new frontiers, eventually leading to abstract painting. "Thus, ironically, through its own vernacular, photography offered ways to overcome a commonplace photographic style." (Scharf, 1983, p.12) "The painter could no longer depict a world that had been much photographed. He turned, instead, to reveal the inner process of creativity in expressionism and abstract art." (McLuhan, 2001, p.194)

2.3.3. Art & Industry

A common attitude against photography as an art concerned how it intertwined art and industry[25]. Something that could be mass produced could not be an art. Did some of its use undermine other uses? Did the availability of the device make it less exclusive and in some people's opinion take away the "divine intervention" that was there in true pieces of art? An early critique from the *Leipzig City Adviser* exemplifies this statement:

> To try to catch transient reflected images is not merely something that is impossible but, but as a thorough German investigation has shown, the very desire to do so is blasphemy. Man is created in the image of God and God's image cannot be captured by any human machine. Only the divine artist, divinely inspired, may be allowed, in a moment of solemnity, at the higher call of his genius, to dare to reproduce the divine-human features, but never by means of mechanical aid. (Quoted in: Tagg, 1988, p.41)

25 Industry – As a result of the Industrial Revolution the term 'industry' had changed from being a particular human attribute to something regarding manufacturing plants and manufacturing processes.

At the Great Exhibition of 1851 in London's newly built Crystal Palace photographs were displayed in the 'Machines' section. Photographers realized that photography needed to be acknowledged as an art to attain social status. (Frizot, 1998, p.94) In 1851 the *Société Héliographique* was formed for the purpose of "the study[ing] and practice of the art and science [of photography]." Subsequently, photographic societies were formed in England, Austria and the U.S.(p.96)

Prior to the exhibition at the *Salon des Beaux-arts* of 1859 "the French government finally yielded to the consistent pressure applied by the *Société française de Photographie*[26] and its supporters. … a salon of photography would now form part of the yearly exhibitions … though with its own entrance". (Scharf, 1983, p.143) The salon got good reviews and attendance and the photographs were compared with paintings. It was acknowledged that photographs could convey the personality of the photographer. (p.144)

Another milestone was a result of the photographers Mayor and Pierson accusing another photographic team of pirating their prints. The copyright laws only applied to the arts. During 1861 and 1862 the case was taken to the courts and it would have to be decided whether photography was art or not. The court ruled against this, but after an appeal it was declared that photography *was* an art. (p.151-52) This was not to be closure though; a petition, signed by a range of artists including Jean-Auguste-Dominique Ingres (1780-1867) [27] and former *Société française de Photographie* members, was presented to the court, but it was rejected and it was declared that "photographs *could* be the products of thought and spirit, of taste and intelligence, and could bear the imprint of the personality." (p.153) The

26 In 1854 Société Héliographique changed its name to Société française de Photographie.

27 Ingres (in 1863, after the rejection of the petition): "They want to mix industry with art! Industry! We do not want it! Let it keep its place and not come and set itself on the steps of our true temple of Apollo, consecrated solely to the arts of Greece and Rome!" (Scharf, 1983, p.154)

use of the word ‘could’ is interesting because it implies that photography was not necessarily an art, it depended on the use and user.

2.3.4. Factotum

It is important to distinguish between photography *as* an art and photography *as a factotum to* art. Even though there is an obvious distinction between the two uses, the first being the main target of this part of the paper, it is important to have a look at the latter because it says a lot about the art community’s perception of photography in general. Some painters took up painting solely to use photography for sketches. (Scharf, 1983, p.111) Artists had been using optical devices, especially as an aid for getting the right perspective, for centuries. Several painters are known for having used the camera obscura extensively, but because its use still stirs up many art critics, the legitimacy of these historic “facts” is controversial. This disparaging view seems to have been widespread in the 19th century as well. Painters often didn’t mention or even denied the use of a camera.[28] After the introduction of the photograph, in contrast with the older, pre-photography cameras, photographs exist that show such a resemblance to paintings that there should be no arguing over whether the painting was painted after the photo or not. Aaron Scharf (1983, p.113) believes it is obvious that many photographs were destroyed, leaving no evidence of the “illegitimate” practice.[29]

This reluctance to admit to use unconventional methods for the production of art is also exemplified by Gustave Le Gray’s (1820-1884) paintings for his “marine studies” exhibition in 1856-57. Overcoming the before artistic boundary of portraying both the sky

28 This secretive attitude were also the focal point of critique. Ernest Chesneau in 1859: “This ingratitude is obvious when one knows that the majority of painters today use photography as their most precious aid. They won’t deprive themselves of it. I find the proof of this use in the general toning down of the color range during the last few years.” (Scharf, 1983, p.144)

29 Jan Vermeer and Thomas Deakins are two painters that are widely believed to extensively have used optical devices for their paintings. Many of Vermeer’s paintings have a perspective that suggests the use of a camera obscura. (Scharf, 1983, p.193) Some of Deakins’ paintings are likely to have been based on a composition of photographs.

with clouds and land/water in the same photograph he stunned the audience.[30] He did not admit that he had been using two negatives that were superimposed at the time of print, something that has now thoroughly proved. (Frizot, 1998, p.100)

Another example of the early use of composite photographs and its controversy is Oscar Gustave Rejlander's famous large photograph, *Two Ways of Life*, which was made from more than thirty different negatives. After exhibiting the painting, Rejlander "made two great mistakes. Firstly, he did not realize that artists would conceal their use of this aid, and, secondly, he was not to know that artists would prefer literal records to work from rather than photographs with a certain creative expression of their own." "Rejlander, like [Julia Margaret] Cameron after him, believed that it was the thought expressed, and not the particular medium, which made an object a work of art. Art was means of making such thoughts possible." (p.187) "The procedure was repudiated in France, and the Photographic Society there prohibited its members from exhibiting photographs made by this method", but the *Art Journal* defended him, stating that it was no different than the practice of a Royal Academician. (Scharf, 1983, p.109)

2.3.5. Ontology

Many of the complaints targeted at photography, independent of the views on photography as art, were due to technical shortcomings at that point in history, and would later become void although the complainers would sometimes continue to hold on to their opinions. The introduction of new technologies often lead to new complaints - as well as praise.

The problem of the long exposure time was the cause of ridicule against photography by several artists.[31] When shutter speed increased to such a point of it

30 "The difficult problem of painting cloud formations with meteorological accuracy […] was an old story in art by the time it appeared that the photograph could be of assistance." (Scharf, 1983, p.113) Photographing clouds and landscape simultaneously was very difficult as "different exposure times were necessary if both the expanse of light sky and the darker tones of the land below were to be recorded properly." (p.114)

becoming possible to take instantaneous photographs,[32] people first criticized the *too* natural poses a photograph now could convey. First in the expression on people's faces, later, as possible exposure time further decreased, the way the now perceivable movements of fast animals encouraged painters to paint realistic but static looking animals. Naturally, there was not only critique as a result of these technological improvements, many were highly welcoming of them and the production of sequential photographs of animal - including human - movement became highly popular and profitable[33]. The critique spurred around how the eye always sees motion, never still images, and if it could, the moment would already be past time. One can only see motion at the moment. So should artists try to convey this motion, what is perceivable by the human eye, rather than a, for a human, unnatural "time stop" image?

Chronophotography was also a result of increased shutter speed, but rather than the sequential photographs of animal locomotion with several photos for several steps of the motion (e. g. a horse's gait), it "revealed the continuity patterns of the movement itself." (Scharf, 1983, p.227) The result was a 4 dimensional, rather than a 3 dimensional, representation of movement. Both Georges Seurat's (1859-1891) painting *Le Chahut* and Marcel Duchamp's (1887-1968) series of paintings, *Nude Descending a Staircase* are among potential and confirmed products of chronophotography's inspiration. (p.227)

A similar philosophical debate was running as a result of the weird perspectives that could be obtained by using different lenses when photographing. The different types of

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31 Another characteristic caused by the exposure time, and possibly another reason for the critique, can be seen on early non-portrait photographs, there's an eerie absence of people, streets are empty even in the middle of the day. As exposure time was gradually reduced, people (and carriages, etc.) started appearing, first as ghostly traces, eventually materializing as themselves.

32 The term instantaneous photograph is relative. A critic wrote after the introduction of the collodion process: "The rapidity is such that a portrait is taken in three seconds. In other words, it's practically instantaneous." (Frizot, 1998, p.99) By the year 1878 Eadweard Muybridge was taking photographs with a shutter speed of 1/1000th of a second and was able to capture motion that was inconceivable for the human eye. (Scharf, 1983, p.213)

33 Not only would painters paint in according to Muybridge's photographs they "would jeopardize their reputations if they did not." (Scharf, 1983, p.222)"'The chief use of the camera to the artist', said John Brett, 'lies in its power of securing images of rapidly moving animals'". (p.222)

perspective that could be obtained using different types of lenses in a camera were also shown in paintings. These sometimes “distorted” perspectives make it easy to distinguish whether an artist has been using an optical device or not when rendering a painting’s perspective. Such use of optical devices met a lot of criticism, and is also interesting because it compromises the photograph’s reputation of being realistic. What should be considered *real*? Is the way the eye sees something the norm of what is *real*? “By the power of its convincing images, photography served, in these and other respects, to undermine any ideas of an immutable perception of nature.” (p.195)

This ’distorted’ perspective was referred to as the ‘modern error’, being ugly and false.[34] Delacroix (1798-1863) and Joseph Pennell (1857-1926) acknowledged that the perspective could not be said to be wrong but it was “artistically grotesque.”[35] (p.193)

34 Francis Frith in the Art Journal “observed that ladies of uncertain age and gentlemen with uncomfortably large noses had ‘taken pains to spread abroad in the public mind an alarming theory about spherical aberration’.” (Scharf, 1983, p.192)

35 Ernst Gombrich: “The greatness of the discovery of Renaissance perspective was not that it conformed to optical truth but that it embodied something more fundamental: the need to see the world that way.” (Scharf, 1983, p.195)

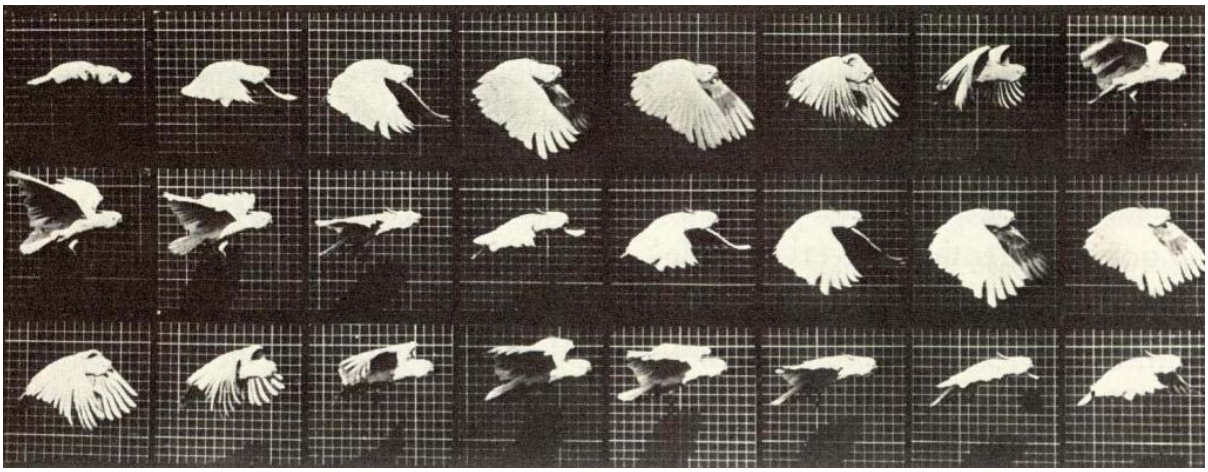

Figure 5: *Cockatoo Flying*. From *Animal Locomotion* by Eadweard Muybridge(1887) (Scharf, 1983, p.220)

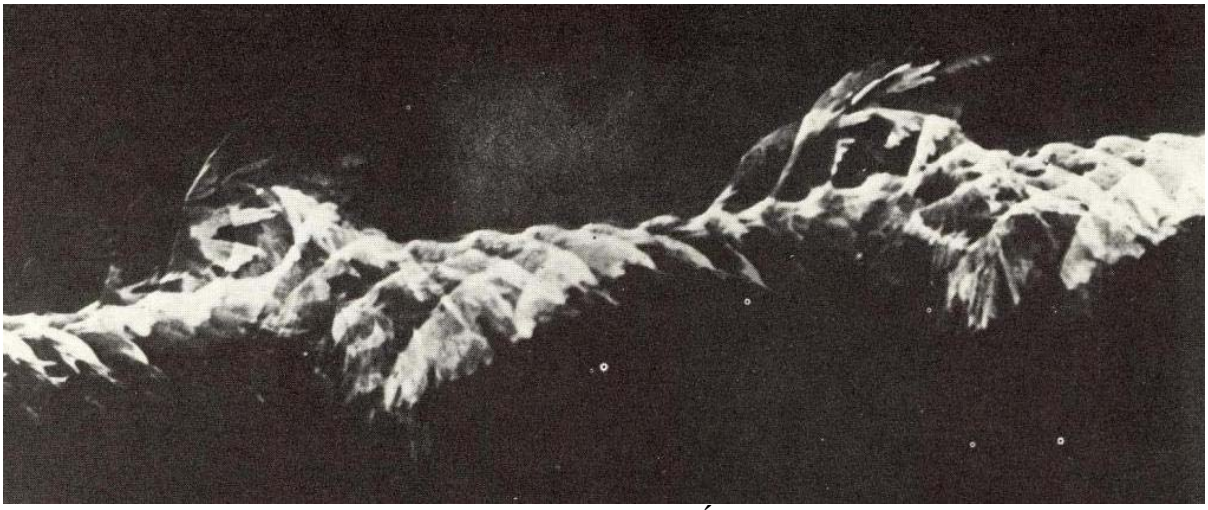

Figure 6: *Chronophotograph of the flight of a bird* by Étienne-Jules Marey(1887) (Scharf, 1983, p.228)

2.3.6. Stabilization

The influence between painting and photography was not one-way; it was a complex relationship where influences flowed both ways. These compounding of influences were crucial for the increased inventiveness in visual arts during the 19th century. (Scharf, 1983, p.11) Each major photographic development "in turn carried a particular meaning for one or other category of art": In the 1840s portrait painting was affected. Later that decade the same happened to landscape painting. The 1850-60s are characterized by realism in art. In the 1860-70s urban realism of impressionist paintings[36] is paralleled by the snapshot, and in 1880s Kodak and high speed cameras created "havoc with the conventional functions of both photography and art." (p.16)

The introduction of the Kodak and the high speed cameras in the late 1800s led to a democratization of photography. It became urgent for artistic photographers to demonstrate that "the camera was capable of taking pictures of artistic merit …, that almost any current style in painting could be paralleled by photography." (p.233) This is similar to the position painters were put in as a result of photography and its devastating ability to show details in mid 1800s. Painters relying on descriptive paintings would have to prove that their work was *above* the work of photographers. In the 1890s, artistic photographers would have to prove that their photographs were something else than the ones taken by the public. To quote Bourdieu: "Photographic virtuosos do not only wish to legitimate a non-recognized activity …; they also attempt, by transforming a technology used for other ends into an

36 The changes in the impressionists painting style can in addition to the influence from the technology of photography be related to the development of the technology of paint itself. The paintings of the time are characterized by newly invented and released painting tools and materials. The new mechanically grinded colors encouraged thick layers, which in turn meant no transparent layers of painting for shadows. New additives to painting also resulted in this. New oil binders, most notably poppy seed oil, that was thick and dried slowly encouraged wet on wet painting. Because of the possibility a larger scale production as a result of mechanical grinding and characteristics of the new colors, there was a pressing need for extended shelf life of the product. By the early 1840s tin tubes had been invented and perfected something that also resulted in portability which in turn encouraged outdoor (plein-air) painting.

artistic medium, to deny the social definition of the uses and possibilities of photography." (Bourdieu, 1990, p.131)

2.4. Final Remarks

With the Kodak camera the technology of photography had reached closure. The Kodak cameras had all the characteristics that people today expect from a camera. It was portable, easy to use, had a decent picture quality, produced reproducible pictures and was affordable. These characteristics have obviously improved over years, but relative to what people expected of these characteristics at the time, it encompassed all that was expected. Cameras can obviously differ in these qualities but collectively, to some extent, these characteristics have remained the target for camera production and development because it is commonly agreed what a camera *is and does.* Arago's role should not be neglected. His rhetoric display at the disclosure of the daguerreotype to the public might have been crucial for setting up the stage for further use. Rhetoric is a significant closure mechanism. (Bijker, 1995, p.279)

As for photography as art, the Kodak camera also played an essential role. It helped distinguish between what was and what was not photographic art. During the century of its conception people had to an extent cut away from the constraints the technological frame of painting had set on them and was able to appreciate photography for its own qualities. People had stopped comparing photography to painting and could appreciate photography on its own grounds. This was also reflected in how photographers would take photographs without complying with the conventions (technological frame) of painting. "From the 1890s, superseding all arguments, photography was accepted as an established form of art." (Scharf, 1983, p.16)

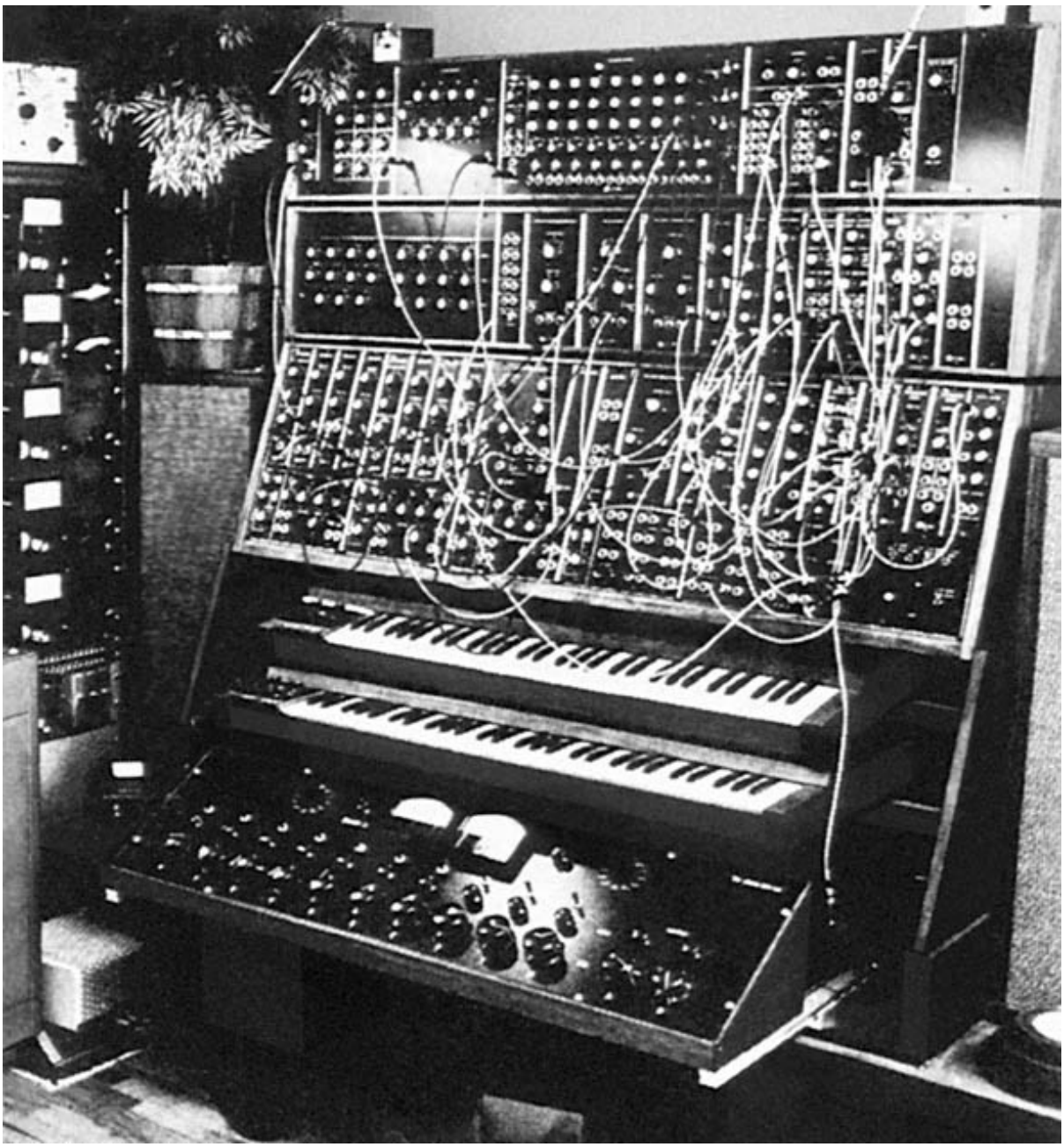

Figure 7: The Moog modular synthesizer Wendy Carlos used to record *Switched-On Bach.* (Website 11)

3. Synthesizing Sounds

> Clearly, musical instruments take part in a dynamic interplay with musical concepts at the most fundamental level. Material culture and abstract systems of musical thought and organization thus form a dialectical relationship of the utmost importance in music-making. (Thebérge, 1997, p.168)

In this chapter I will look at how the process of synthesizing sounds was developed through technology, and how this related to new musical paradigms of the 20th century. I will analyze the development of the process as technology and the process as art. In the analysis I will, as in the previous chapter, use SCOT as a guideline to ensure focus on the social factors that contributed to the shaping of the process.

The use of technology has been of major importance in the western musical tradition. Some of the most complex artifacts, at the time of their origin in history, have been musical instruments, such as the piano and the organ, and contrary to painting the use of technology has been much more widely accepted as being a necessity. Although the uses of technology for musical experience have through history been at the threshold of technological possibilities at their time, the radical changes during the 20th century differ greatly from those previous innovations as the whole foundation of musical composition was greatly changed. Because the use of instruments have always been restricted by human limitations, there have concurrently always been incentives to make instruments that could enable even more complex music Because the possibilities of musical creativity seems endless and the human body (at least still) has major limitations, the incentives will always be there (, and without necessarily compromising important artistic virtues such as

diligence.) Another reason for making new instruments is the enabling of new unique sounds. The developments of electronic instruments were often predated by concepts and needs that had been influenced by a new way of thinking about sound, often heralded by the avant-garde[37]. The knowledge of the characteristics of sound itself, with and without relation to music, is also something that has evolved tremendously over the last 150 years.

3.1. Brief history

During the 19th century many of the properties of sound were described by the German scientist Hermann von Helmholtz (1821-1894) and in the advent followed a whole new way of thinking about sound. Because there were now explicitly defined characteristics of sound (as) waves it was theoretically possible to manipulate sound in a nearly systematic manner.

With the use of electronics it became possible to in theory create any sound imaginable, through manipulations based on the new discoveries of the characteristics of sound. Most profound is the inclusion of atonal sounds and noise in music, both as pre-recorded natural sounds and synthesized sounds. In fact the whole idea of sound has been radically changed because there are no longer any limitations of what sounds to use in music. There is no longer a preset array of instruments; a composer has the opportunity to customize sounds of choice.

As recording equipment became more sophisticated, especially through the diffusion of the magnetic tape, recorded and live music started to differ greatly. Possibilities of the manipulation of sound arose in the music studies that were not, at least often initially, possible to reproduce on stage. Instead of writing music for people to play, music was constructed in the laboratory-like music studio.

[37] Originally, 'avant-garde' was an expression used in the French military for the first line of soldiers in battle. In the late 19th century, Parisian artists started using the term, "no doubt because they too felt the somewhat daunting futility of putting their careers on the line while battling the more conservative tastes of the typical patron of the arts." (Holmes, 2002, p.31)

With the introduction of analog synthesizers such as the Moog synthesizer and the Buchla Box, composers finally had the necessary equipment to explore many of their visions. It was the Moog synthesizer that carried the use of electronics away from the oddities of the avant-garde and into other types of more conventional music, such as with Wendy Carlos' *Switched-On Bach*.

Today the legacy of the first synthesizers is seen in various incarnations such as the drum-machine, different types of synthesizers and an array of studio equipment. Concurrently, popular music has incorporated elements of synthesized sounds. "Music as we know it today – in all of its many-faceted, genre-bending splendor – would not exist without technology…All music today is electronic music." (Holmes, 2002, p.1)

3.2. Analysis of Technology

3.2.1. Pioneers

The first synthesizer, or possibly more accurately, the first device that was labelled 'synthesizer', was known as the *Dynamophone* or *Telharmonium* and it was a truly ambitious project. (Holmes, 2002, pp.44-45) The idea behind was as grandiose as its physical size. On February 4, 1896, Thaddeus Cahill (1867-1934) filed a patent for a machine to produce what he labelled 'electronic music'. The 'grand objects' of the invention was according to Cahill to "generate music electrically with tones of good quality and great power and with perfect musical expression, and to distribute music electrically by what we may term 'original electrical generation' from a central station to translating instruments located at different points." (Quoted in: Holmes, 2002, p.45) With the second prototype[38] of the machine Cahill's dream was nearly fulfilled. After a number of successful demonstrations in his home city it was moved to New York City in 1906. Cahill managed to

[38] Cahill never got the chance to build a Telharmonium according to his specifications.

acquire some subscribers for his service including leading hotels and restaurants as well as wealthy people, but soon problems arose. The machine was like a small power plant, and its massive consumption of power caused interference in phone lines, deteriorated the sound of the instrument itself and eventually the phone company terminated the contract with Cahill.

Paul Thebérge describes the Telharmonium as "poorly designed in the first place" in the book *Any Sound You Can Image*, and concludes with offering two reasons for its failure: "first, because of basic problems of cost and design, and second, because of Cahill's own limited perception of the role such an instrument could play in musical culture." (Thebérge, 1997, p.44) Because the Telharmonium was to an extent a failure, it is easy in hindsight to come with such simple conclusions but I believe that it is important to understand that at the time the Telharmonium must have been seen by quite a few people as a remarkable invention, although obviously a subject of considerable interpretable flexibility. It could have been otherwise.

Cahill's idea dated back to 1884, when he as a student appears to have been influenced by the works of the German physicist Hermann von Helmholtz' pioneering work on the science of acoustics. (Holmes, 2002, p.14, p.45) In 1862 Helmholtz published a paper called "Sensations of Tone" where "he demonstrated that musical sound could be analyzed according to a few basic principles" and that sound consisted of several component parts. (pp.13-14) The knowledge of acoustics grew alongside the increasing knowledge of electricity, and throughout the 1800s several more or less accidental discoveries resulted in an array of weird musical contraptions[39], but they were all "dramatically eclipsed by the work of Thaddeus Cahill". (p.44)

With the introduction of the vacuum tube it became possible to develop electronic instruments in a realistic size. The *theremin* was one of the earliest electronic instruments

[39] One of these contraptions was the result of the English physicist William Duddell's attempts at eliminating the "annoying whining" sounds from streetlights. He eventually attached a keyboard to the circuitry of the light and with some success toured playing the "Singing Arc." (Holmes, 2002, p.44)

"to capture the fancy of audiences and composers alike". (p.53) It was built by Lev Sergeyevich Termin (1896-1993)[40] in his home country Russia in 1920[41], and in 1927 it was used in a public performance for the first time in the U.S. After obtaining a licensing agreement with the radio manufacturer RCA, the *RCA Theremin* was introduced for the public in 1929, but with little success[42]. The design of the theremin made it notoriously hard to play; the instrument looked like a radio and was played by moving ones hands in the proximity of its two antennae, one controlling pitch and the other controlling loudness. The theatricality of the performance and the characteristic eerie sweeping sounds of the instrument made it a popular attraction during the years before the big depression, and Termin himself continued to develop electronic instruments, sometimes on commission. In 1937 Termin left the country in the midst of charges of being a Soviet spy, and by that time the theremin's popularity had dwindled.

But Theremin's legacy lived on. At a *New York State School Music Association* conference in 1963 Robert Moog (1934-2005) was approached by music instructor Herb Deutsch. Moog had been making and selling theremin kits for a while and was demonstrating a theremin at the conference. After talking for hours, Moog was invited to a concert of Deutsch's music. The concert spurred Moog's enthusiasm for electronic music and the two decided to "get together for some constructive brainstorming and tinkering." (Holmes, 2002,p.164) The fruits of their initial collaboration were a musical piece by Deutsch called *Jazz Images* and a prototype synthesizer.

[40] Also known by the anglicized version of his name, Leon Theremin.
[41] Lenin was impressed by the invention and received lessons from Termin. There were several tours around Soviet, on Lenin's command. (Van Dulken, 2002, p.76)
[42] Only 500 RCA Theremins were sold. (Holmes, 2002, p.54)

Figure 8: Leo Termin with theremin (Website 8)

3.2.2. The Analog Synthesizer

Moog and Deutsch showed the proto-synthesizer to several musicians, got new ideas, and eventually were invited to the *Audio Engineering Society* (AES) convention in the fall of 1964. At the convention Moog sold what turned out to be the first commercially made *Moog synthesizer* to choreographer and composer Alwin Nikolais (1910-1993) of the *Nikolais Dance theatre,* who was backed financially by the *Guggenheim Fellowship*. At this time the synthesizer consisted of several modules, or wooden boxes with electronics inside. Each did different things to the electric circuits that passed through, shaping the electric waves, which in effect shaped the sound of the output. It was up to the musician to decide which modules was needed for the required purposes.

Don Buchla (1937-) had already been working on voltage control for a few years when Morton Subotnick (1933-) and Ramón Sender (1934-) announced they wanted an audio engineer to help them build new devices for creating electronic music. Like Moog, Buchla had been tinkering with electronics since childhood, but unlike Moog, Buchla was a musician and had a "strong, natural affinity to the needs of the composer." (Holmes, 2002, p.182) As with the collaboration between Moog and Deutsch – the engineer and the composer – Buchla's collaboration with Subotnick and Sender bore fruit. In the fall of 1965 Buchla exhibited a prototype *Buchla Box* at the *San Francisco Tape Music Center*, where Subotnick and Sender were working. The Buchla Box used many of the same basic principles as the Moog synthesizer, but contrary to Moog's synthesizer, the Buchla Box was not pre-tuned into the standard octave system and different touch pads were used as controlling device rather than a keyboard. Buchla also introduced the sequencer[43] for the commercial synthesizer.

[43] A sequencer provides "a way to 'program' a series of repeatable sounds".(Holmes, 2002, p.183)

3.2.3. Different Ways to Success

Over the following years the design of the Moog synthesizer was in constant flux. One important feature that has been prominent in the synthesizer's later developments was the use of a keyboard as a controlling device. The composer Vladimir Ussachevsky (1911-1990) argued that Moog should not use a keyboard as a controlling device as it would set the use of the synthesizer on the wrong path. Using a keyboard would encourage keyboard type of music rather than the experimental music Ussachevsky advocated. Moog had earlier developed a new technique for shaping the envelope of sound[44] with Ussachevsky and "was not strongly wedded to the keyboard as a controller", but Moog's collaborators Walter Sear (his sales agent) and Deutsch advised/pressured him to use the keyboard[45]. (Pinch&Trocco, 2002,p.59) They both recognized the commercial appeal of the keyboard. In the 2004 documentary *Moog* (Fjellestad, 2004), Deutsch acknowledges that Ussachevsky, as seen in retrospect, was partially right. The use of the keyboard did set the synthesizer on a certain path and resulted in the synthesizer also being widely used for playing typical keyboard music; music that didn't require the synthesizer.

Moog was always listening to his customers' demands and worked in tight collaboration with several musicians. As a result of this, the Moog modular synthesizer was very versatile and was used for greatly varying purposes, from commercials and soundtracks to avant-garde and pop music. Buchla, on the other hand, had no interest in adhering to the wishes of others. He stated that not having a keyboard as a controlling device is "appealing to fewer people but it's more exciting." (Quoted in: Pinch a& Trocco, 2002, p.44)

[44] A sound's change of loudness over time. The pedals on a piano are used for this, although to a very limited extent compared to the capabilities of a synthesizer.
[45] Moog also invented the *ribbon controller* as a controlling device.

Although the Moog synthesizer is better known, the degree of success is highly relative. Buchla never wanted mass appeal and retained control over his production (unlike Moog) even throughout the "synthesizer marketing wars" that drew many companies out of business during the 70s and 80s. Buchla is "recognized today as a kind of musical engineering guru" and is still making musical instruments. He is responsible for a wide array of, sometimes weird, musical contraptions, some incorporating digital technology such as the Musical Instrument Digital Interface (MIDI) standard. (Holmes, 2002, p.185)

It was not until the release of the record *Switched-On Bach* by Wendy Carlos (1939 -) in 1968 that the Moog synthesizer became a household name. Carlos had been a part of the academic electronic music milieu and had provided Moog with many suggestions for his synthesizer. Carlos wanted "to use the new technology for appealing music you could really listen to" rather than the "academy approved 'ugly' music." (p.166) *Switched-On Bach* consisted of works of Bach being played solely on the Moog modular synthesizer and became the best selling classical record of all time, selling more than 1 million copies[46]. As a result, there was suddenly a great demand for synthesizers.

[46] It received a gold record in August 1969 for having sold 500,000 copies. Later that year it received 3 Grammies.

Figure 9: Moog (left) and Buchla with their synthesizers (ca. 1968) (Website 9)

3.2.4. Electronic Instrument Success Stories

The Moog synthesizer was not the first successful electronic instrument. The *Hammond organ* was invented in 1933 by Laurens Hammond (1895-1973) and was undoubtedly the most successful keyboard innovation of the first half of the 20th century. “Hammond’s electromechanical method for generating musical notes was identical to that used in the Telharmonium”, but new technology, such as vacuum tubes, allowed Hammond to fit everything into a small cabinet. (Holmes, 2002, p.74) Hammond succeeded because of both technical and production innovations which enabled him to make mass-produced quality instruments. Hammond also realized that his intended church market should not be the limitation; he recognized a big market among professional and amateur musicians. (Thebérge, 1997, p.46) In contrast to the Moog synthesizer, the Hammond organ was made to mimic the sounds of a pipe organ, and not to create new sounds.

Interestingly, the Hammond organ became a hit in Japan as a result of the Japanese weather. Other brands of electric organs could not handle the humid Japanese climate, but

the Hammond organ was built of parts that could handle it.[47] (Kakehashi, 2002, p.167) Ikutaro Kakehashi (1930-) started his venture into the electronic music market by reverse engineering Hammond organs. He later became a Hammond sales rep, before he founded the *Roland Corporation*. Today, Roland Corporation is the world's number one manufacturers of synthesizers and is also known for their range of drum machines, especially the *TR-808.*[48](Kakehashi, 2002)

With the *Minimoog* – "the first synthesizer ever to become a 'classic'"(Pinch & Trocco, 2002, p.214) - the path of the synthesizer seems to have been set. The Minimoog was originally a lunch break project started by one of Moog's employees, and was initially met with little enthusiasm from Moog himself. But it was approved and used by musicians such as David Borden of Mother Mallard and free-jazz visionary Sun Ra, and eventually production commenced for commercial purposes. "The instrument's portability, ease of use, and relatively stable oscillators[[49]] made it ideal for live performance." (p.214) It remained in production for 12 years and more than 12,000 units were sold. The Minimoog is "the most popular and widely used synthesizer of all time." (Holmes,2002,p.182)

3.2.5. Building the Market

Because the synthesizer did not fit into the technological frame of the music retailer relevant social group, it was hard to convince stores to stock synthesizers. This was a huge problem for both Moog and ARP Instruments, Moog's most powerful rival around 1970. The role of the salesmen of both companies was crucial for enrolling potential retailers into the values of the synthesizer manufacturer technological frame. Pinch and Trocco refer to the salesmen as boundary shifters, as they "cross boundaries and in so doing produce a

[47] This was wholly unintentional. Because of the otherwise weak signal of the tone generating mechanism, palladium had to be used in the instrument. (Kakehashi,2002,p.167)
[48] The Roland 808 series drum machine is featured in a majority of hip hop productions.
[49] Oscillators provide the electric current/wave that is later altered by the different parts of the synthesizer and eventually transformed into analogous air waves – sound.

transformation."(Pinch & Trocco, 2002, p.52, p.314) Slowly the synthesizer was accepted as an instrument, rather than a studio machine. In 1971 Moog displayed his synthesizer at the *National Association of Music Merchants* (NAMM) trade show, rather than at the *Audio Engineering Meeting* he had attended over the previous years. (Thebérge, 1997, p.54)

3.2.6. Digital Technology

Because the synthesizer, as a result of the popularity of the Minimoog, had an apparent resemblance to other keyboard instruments, certain features were expected. A polyphonic keyboard was one of the features that was expected but because of the reluctance to the use of new types of technology, namely digital ones, the development took too much time and it was never a success. This is a clear example of functional failure. The engineers were too stuck in the technological frame of analog technologies to realize that there were other and easier solutions to their problems. (Thebérge, 1997, pp.56-58)

Digital technologies have brought a whole new age to synthesizers. The use of microchips has greatly reduced the size while increasing the reliability of synthesizers. Software that mimics the components of a synthesizer have allowed for music making on personal computers. Such so called virtual synthesizers have highly democratized the possibilities of sound manufacturing and music production, as they are relatively cheap and do not require state of the art computers. Another important innovation is the MIDI standard. The MIDI protocol was introduced in 1984 and communicates different characteristics of sound (like pitch) that are independent of the instrument that is used to play.

Thebérge argues that, entering the digital age, instrument makers became a part of a bigger technological picture; they no longer invented new technologies but rather waited for others (computer companies) to invent the technologies that they would later use.

(Thebérge, 1997, p.55-57) It would be interesting to know whether the instrument makers have a technological determinist stand.

3.3. Analysis of Art

3.3.1. The Depart from Conventional Music

"Electronic music is an outgrowth of larger trends in twentieth-century music and culture" and includes the development of avant-garde music and new electronic instruments. (Holmes, 2002, p.31) At the end of the 19th century, some composers started to question the limitations of the equal-temperament scale, the tuning system that was developed in the 17th century as the "de facto standard for use in orchestral music." (p.32) They wanted to utilize the possibilities of microtonal scales[50] something that was unheard of in the contemporary technological frame of the conservatories.

Erik Satie (1866-1925) and Claude Debussy (1862 - 1918) were forerunners in the use of unconventional scales. Both were "disillusioned with the current condition of music" and as their ideas were met with resentment from the academic establishment, they turned to the Parisian avant-garde. Many composers followed up on the exploration of music opposing the standard chromatic tonal scale. Ferruccio Busoni (1866-1924) was one of them. Inspired by the telharmonium of Cahill, he wrote the famous manifesto *Entwurf einer neuen Ästhetik der Tonkonst* (*Sketch of a New Aesthetic of Music*), describing the instrument's prospect for playing microtonal music. It was not until the development of analog synthesizer in the 1960s that his visions became truly achievable. (Holmes, 2002)

[50] Scales where the octave was divided into more than twelve steps. The equal-temperament scale was a western tradition and is not found in all world music. There are scales with more or fewer tones and equal or unequal steps between them. (Holmes, 2002, p.32)

In the decades around the turn of the twentieth century there was much exploration into the possibilities of sound and music, but it was eclipsed by the Futurist[51] movement's burgeoning interest in the use of noise in/as music. After having been inspired by a fellow futurist's escapades into the newly (re)introduced[52] realm of atonal music, the painter Luigi Russolo (1885-1947) wrote *The Art of Noise* (1913) were he envisioned the use of sound in music. Russolo's manifesto is "an impressive document and certainly an influential precursor of modern experimental music." (Holmes, 2002, pp.38-39) He went on to build an array of noise-producing instruments - intonarumori ('noise-intoners') - that were basically wooden boxes with megaphones filled with different mechanical devices. Russolo also started writing music and his first concert was held in Rome April 1914. While music patrons had been "politely humoring the eccentric approaches to tonality" in the works of composers such as Satie and Debussy (p.37) the reactions to this concert was quite hostile. The audience threw rotten fruits and vegetables at the musicians throughout the performance, but it was all topped by Emilio Marinetti (1876-1944)[53] and Russolo getting arrested for having provoked a riot. The two continued to perform around Europe, receiving horrible reviews. (Marinetti, on the other hand, declared the performances as highly successful.) (p.41)

As grounds for both the mentioned manifests can be seen in how the authors rebelled against the tradition of music at that time – they had low inclusion in the technological frame of music. They both objected to what they saw as the limitations of the music, or in SCOT terms, they acknowledged the presumptive anomaly of the current musical tradition. They felt that music as it was commonly perceived had no future and that something needed to be done. (Bijker,1995,p.278)

[51] Futurism was an art movement. They had a primary focus on the visual arts.
[52] It is important to note that so called 'unconventional' scales were not new, and that 'conventional' scales are a human construct.
[53] Widely regarded as the founder of the Futurist movement.

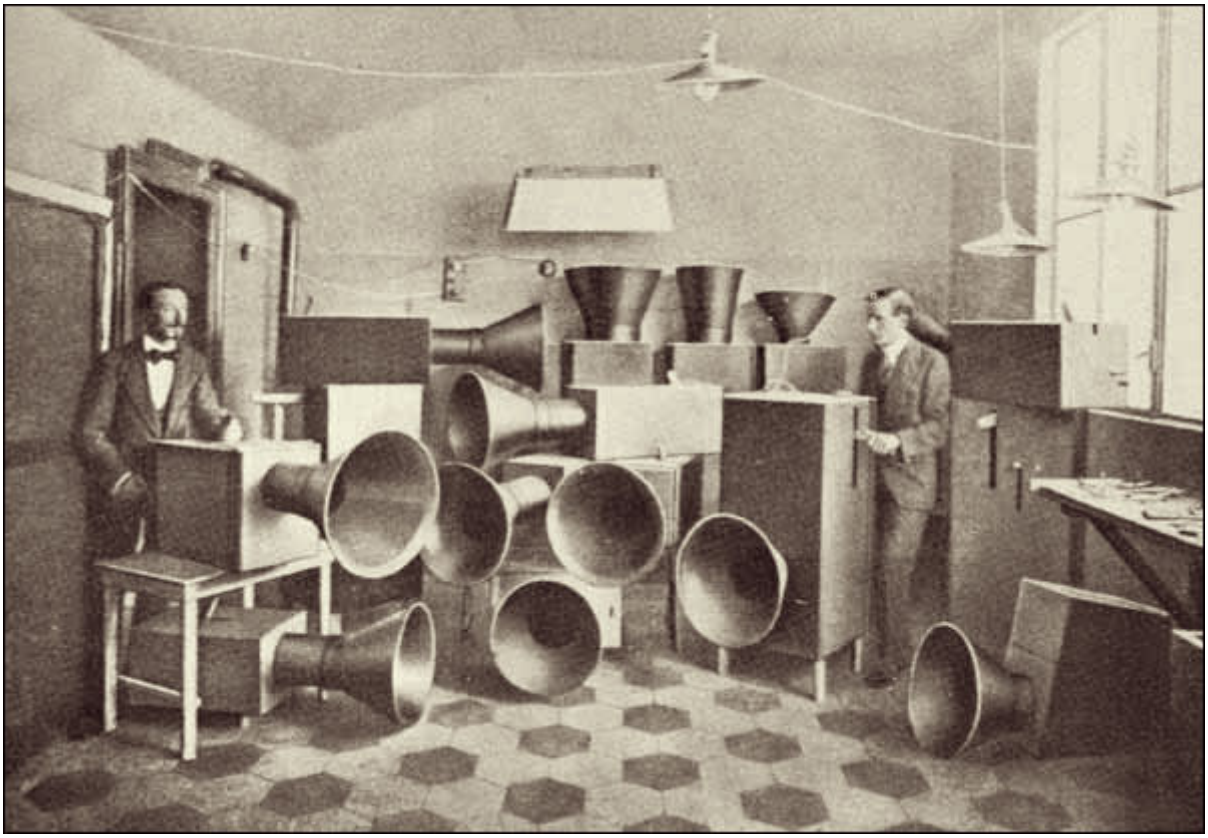

Figure 10: Russolo and assistant with *Intonarumori.* (Website 10)

3.3.2. Studios and Institutions

Prior to the diffusion of the magnetic tape recorder[54], the possibilities in recording music had been limited to whole sets of music[55]. With the tape recorder it was feasible to put together bits and pieces of music. John Cage (1912-1992), a forerunner in avant-garde music, stated that the tape recorder "immediately changed the notation of music. We could put a sound at any point in time." (Quoted in: Holmes, 2002, p.78) Techniques were applied to change sound itself. Composers could change the envelope of the sound by cutting of parts of the tape. Speeding up or slowing down the tape was another way of altering the

[54] The magnetic tape recorder a product of Nazi-Germany and became commonly available after WWII.
[55] As history has shown, artists' ideas often predates technological developments. John Cage on music using records: "When the magnetic tape recorder came out …, they new exactly what to do with it." (Quoted in Holmes, 2002, p.77)

sound. By splicing together a tape from end-to-end one would get a loop, the same music continuously repeating itself. Loops could also be used to create echo and reverberation. They were not only producing music but reproducing music. (Thebérge, 1997, p.2,3) “In the ensuing years, this process of reassembling fragments of sound has been called dub, disco, hip-hop, house, drum and bass, trip-hop, electronica – heck, even rock ‘n’ roll.” (Shapiro, 2000, p.3)

The majority of experimental music was now made in the studio, with little possibility of being played live.

The experimental use of the tape recorder was pioneered by Pierre Schaeffer and Pierre Henry at the *French National Radio and Radiodiffusion-Television Françaises* (RTF). They recorded sounds from nature (as contrary to musical instruments) which they processed and edited until they were recorded in their final structure. The music was labeled musique concrète. *Groupe de Recherches Musicales* (GRM), a studio devoted exclusively to electronic music, was established in 1951 with the financial backing of RTF – a result of the success of several experimental compositions. (Holmes, 2002)

Around the same time, in Germany, *elektronische Musik* (electronic music) was being made at the *West German Radio* (WDR) in Cologne. Rather than making music out of an array of recorded sounds, they were making music of pure, electronically generated sounds. “The intellectual animosity that existed between the WDR studio in Cologne and the RTF in Paris was tangible,” it was even compared with the cold war. (p.100)

Initially, and through various reasons[56], the European studios had been the epicenter of electronic music. After years of moving around, and a pilgrimage to the Paris and Cologne studios, the American composers and Columbia University music instructors Otto Luening (1900-1996) and Vladimir Ussachevsky (1911-1990) eventually got to set up the

[56] “One part of the working arrangement with composers was that their music would be featured regularly in nationally broadcast concerts. It was a time of unprecedented exposure for music in Europe.” (Holmes, 2002, p.85)

studio that was to become the *Columbia-Princeton Electronic Music Center*. At the other studios' envy Luening and Ussachevsky managed to get a hold of the RCA Mark II synthesizer, and with it they elevated their studio "to the forefront of the world's leading studios." (p.111) The studio was regularly visited by leading composers.

The strict technological frames of both the European studios resulted in a very rigid approach to new music, as Holmes puts it, "there was nothing accidental about the first electronic music compositions made at the WDR studio." (p.103) This conforms well with Bijker's configuration models. Actors with high inclusion in a technological frame tend to produce conventional inventions. (Bijker, 1995, p.276)

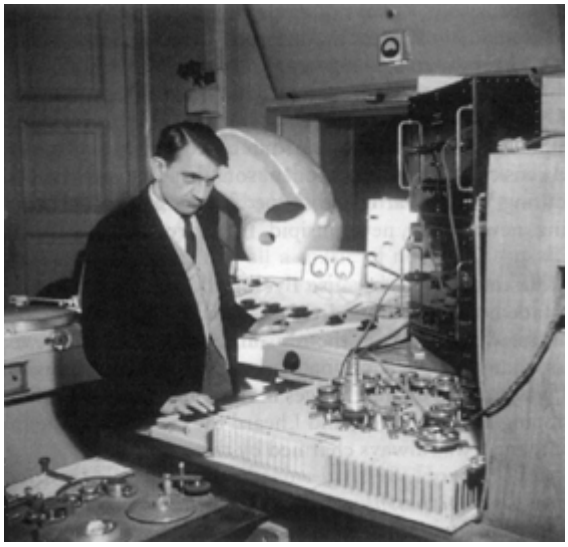

Figure 11: Schaeffer at GRM studio. (Website 12)

3.3.3. Electronic Music Goes Public

Although commonly featured in movie soundtracks and commercials it was not until the release of Wendy Carlos' *Switched-On Bach* (S-OB)(1968) that electronically made music caught the attention of the public. "There is no doubt that Wendy changed the public's[57]

[57] This includes keyboard players such as Keith Emerson and Stevie Wonder - "it was *S-OB* that switched on their own interest in the synthesizer." (Pinch & Trocco, 2002, p.147)

notions about electronic music and the synthesizer", (Pinch & Trocco, 2002, p.147) but its success was also a part of a burgeoning synthesizer trend. The psychedelic movement had already been enjoying synthesizer music[58] and several rock bands had been using the synthesizer for a year prior to the release of *S-OB*; the record was a "part of a much wider cultural transition encompassing the changing expectations of musicians and listeners – electronic sounds were now in the culture. … [But] Carlos' influence was unsurpassed. It brought the synthesizer from psychedelic obscurity fully into the mainstream, where it had remained ever since." (p.154)

Artists such as *the Beatles*[59] dabbled with avant-garde music but received little praise. (Shapiro, 2000, p.20) *Emerson, Lake and Palmer* were met with more success, and in the early 1970s electronic music started fusing with pop music.

Kraftwerk was the group that really bridged the gap between popular and electronic music. Their three first records proved inspiration from the likes of Cage and Stockhausen. "Then they staked everything on the idea that the synthesizer was the future and won." They are revered as godfathers of several styles of modern electronic music. (p.33)

Today technology plays an increasingly bigger role in the world of music, for good and for bad. It has resulted in the democratization of music in the form of internet marketing and cheap production software[60]. On the other side, "a common lament of the past decade has been that, despite the apparent power and diversity of new musical instruments and recording devices, everyone's work was beginning to sound the same… The limited range of sounds built into some drum machines and synthesizers [have] virtually forced [musicians] to write music in a particular style." (Thebérge, 1997, p.1)

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[58] Especially at the infamous trips festivals, the brainchild of Ken Kesey (author of *One Flew over Cuckoo's Nest)*. (Pinch & Trocco, 2002, pp.94-100)

[59] George Harrison even did a whole solo album of electronic music, *Electronic Sounds* (1969). It failed miserably.

[60] E. g. the critically acclaimed first album from The Streets (aka Mike Skinner), *Original Pirate Material (2002),* was produced solely on Skinner's mum's laptop computer.

3.4. Final Remarks

> Robert Moog: There's an interaction between art and technology: That has always been true. It's not that one dictates the other, but when a technological development comes out that musicians can use, musicians use it in a new way. That in turn inspires further technological development. I can remember when I first began, the voltage control was a brand new piece of technology, but it was also a brand-new musical resource. The two were developed together. Not all the mainstream is computer-controlled, but it's the same musical mainstream that began in the sixties. (Quoted in: Shapiro, 2000, p.208)

In accordance with Moog's statement, I have shown that the development of the process of synthesizing sounds was a collective effort between musicians and the producers of the instruments. I have also shown that there were many conflicting technological frames both when it came to what the technology should be like and what the art should be like.

We have seen that reactions to a newly introduced process varied from resentment to attraction, and that over time, people's opinions changed. Some individuals seem to have played a larger role in the process, but all in all collective attitudes had to change.

I will also argue that Western literature neglect the influences that might stem from non-western cultures. According to Roland founder Kakehashi, a *Japanese* performer - Isao Tomita - started a wave of non real time music that was at least as big as the one started with S-OB. This was not mentioned in any of the other (western) books I have read on the subject. As Japanese companies now are market leaders in the synthesizer industry, it would be foolish to disregard his remark as national pride. (Kakehashi, 2002, pp.190-191)

As in the previous chapter there are examples of technologies that was released before perfection and that this limited their potential for commercialization. The same can be said about the art. Nevertheless, their role in the history has not been less important

because of their ‘failure’. Both the Telharmonium and the music of the futurists were crucial for inspiration for further developments in their respective fields. They set the stage for new technological frames.

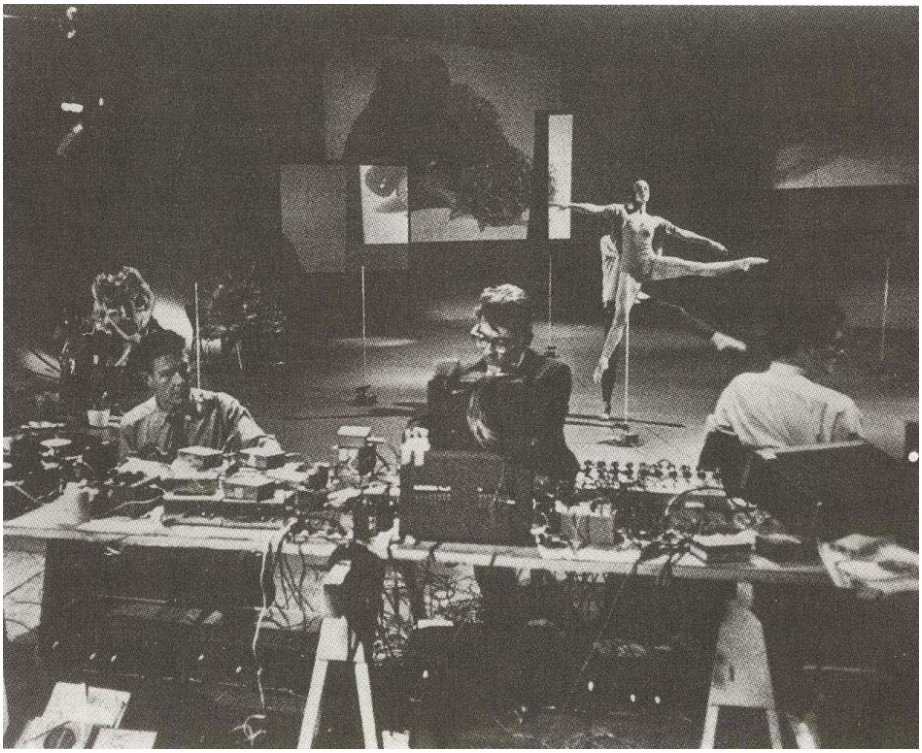

Figure 12: John Cage performing live. (Holmes, 2002, p.129)

4. Discussion

I have throughout the previous two chapters offered an account of how two (sets of) technologies came to be regarded as (by the majority) legitimate accessories for use in the arts, as well as how the technologies in themselves transformed the current state of art, both through new possibilities set forth by the technologies themselves and the way they changed the attitudes of relevant social groups. To achieve this I have based my research on SCOT theory. In this chapter I will start by looking at similarities and differences between the two case studies, then have a look at how art development complies with SCOT theory. Finally, I will look at the classification of art and technology.

4.1. Comparative Analysis

To make sure avoiding the perceived trap of technological determinism, SCOT places the engine of change on society rather than on technology itself. Therefore I have tried to look at the people rather than just the technology, and to analyze through the choices, demands and attitudes of these people, how the technologies evolved into where we find them today. As I did not have the opportunity to recapitulate the whole story in the respective cases, I have capped the stories at the time when there seemed to be a common consent to the nature of the technology. Or in SCOT terms: when closure occurred, when the artifact had reached a certain degree of stabilization, when the interpretable flexibility had decreased to a minimum. Supposedly, an artifact, reaching stabilization, is set on a strict path which discourages further radical developments. This is commonly referred to as path dependency. This will be right to a certain extent. Good examples include the use of keyboard as a

controlling device, and much of art's pedigree's constraint over further development in art. The formation of a new technological frame is analogous to a paradigm shift. With art such change is sometimes represented explicitly through manifestoes, such as *The Art of Noise*. Because of the low inclusion in the technological frame of music, the (perceived) presumptive anomalies of the current tradition of music were acknowledged and a new path was set.

4.1.1. Innovating

According to Bijker (1995), the introduction of a new technological frame might be a result of individuals with low inclusion in a technological frame acknowledging that the course of the current frame will lead to future 'failure'. As a result, a radically new perspective is seen as imperative. Bijker refers to this as presumptive anomalies, and as the name suggests, they are merely based on an actor's account on what is probable. A good example from the history of photography is when Robison in 1839, after having witnessed the daguerreotype, exclaimed that photography could portray light in a specific way[61] that painting never could. A few decades later, Claude Monet proved him wrong with his famous haystack series. (Scharf, 1983, p.35)

In the photography case, the possibilities were there long before the birth of photography. Only the time between Niépce took the first picture and Daguerre released the Daguerreotype could be labeled an innovation period. With the synthesizer, the Telharmonium could be considered the initial invention, while the Minimoog was the innovation. The time lag between invention and innovation is often due to a lack of all necessary conditions for commercialization. (Fagerberg, 2005, p.5) In this regard the major innovation process in the two cases varied greatly. With photography, the leap from

[61]Robison: "A set of three pictures of the same group of houses, one taken soon after sunrise, one at noon, and one in the evening; in these the change of aspect produced by the variations in distribution of the light, was exemplified in a way art could never attain to." (Quoted in: Scharf, 1983, p.35)

invention to innovation concerned technological shortcomings rather than a focus on building the market. Painting and other visual arts had paved the way for photography, and for Arago it was only a matter of announcing potentials of use. With the synthesizer innovating meant not only showing the consumer why they needed the product, but it was also a result of current trends in music. Moog succeeded because he listened to the customer, without bias, and therefore built a product according to the market's wishes. Cahill, on the other hand, managed to create a market for his product, but external factors prevented him from succeeding.

Thebérge argues that the reasons for why most of the early attempts at making electronic instruments failed, was due to "the nature of the early industry, the collaborations that existed between individual musicians and entrepreneurs, the difficulties in gaining widespread acceptance for the instruments, and the limitations of the inventor/entrepreneurial form of organization". (Thebérge, 1997, p.42) The futurists' attempts at performing their new type of music were not welcomed by the audience because the audience's technological frame was still too bound to the ideals of classical music. The development of new musical resources in different genres of music had to prepare listeners for music where noise was an essential part; the audience had to learn how to experience them aesthetically. (Holmes, 2002, p.93) (Becker, 1984, pp.304-305)

4.1.2. Malleability of Technology and Art

In both cases, a common denominator has been the widespread confusion around what the technology is – and does. The *is* can again be divided into ignorance - as in not knowing what a technology is because it is a black box, and the fact that the name of the technology can refer to many different artifacts. What a technology *does* can be divided in a similar fashion; not knowing the uses because of ignorance, or because the uses are many and constantly changing.

It is with the use of the technology the two cases have the most in common. A camera can be used for documenting, reproduction and just for capturing something that might or might not be aesthetically appealing.[62] For artists this constitutes three highly different uses:

- Documentation – as when used as an aid for artists, as a sketch
- Reproduction – reproducing other types of art such as architecture and, most importantly, painting
- Art photography

These uses should have demanded different responses from the same artist, and often did. Many were critical towards acknowledging photography as art in itself, while praising its potential as an aid; i.e. replacing the sketch.

With the synthesizer, its use can be divided into at least two categories:

- Producing and shaping sound
- Emulating (/mimicking) sound

Interestingly, the ability of shaping sounds led to the possibility of emulating other sounds, but today the emulation of other sounds is done through encoding (digitizing) pre-recorded sounds.

Both technologies' different range of uses has resulted in an array of offspring with only limited possibilities of (intended/scripted) use. Examples include the photocopier and photography, and the drum machine and synthesizer.

With the introduction of the camera, manmade images were no longer necessarily a plastic art. On the contrary, the introduction of the synthesizer and the possibility of creating

[62] What is aesthetically appealing is obviously subject to much debate. Siegfried Kracauer argues that a photograph is photographic only if it conforms to a basic principle. Unintentional photographs can have *another* type of beauty, but "adds nothing to the aesthetic legitimacy of such mechanical explorations of nature." (Kracauer, 1980, p. 257)

customized sounds can be seen as a move in the opposite direction. Vast possibilities of moulding were now possible.

This is interesting as there are strong feelings concerning whether technology enables more opportunities, or less *in art*. In respect to the cases I have described, photography had less opportunities compared to painting, reducing the plasticity of visual arts. The synthesizer opened up an array of vast possibilities of shaping sound, adding a new dimension of plasticity to music.

4.1.3. The Use of Technology in Art

It was not uncommon to be against the notion of photography as art, while still approve of the camera in itself. It was hard to discredit the camera in respect to its services for science. Similarly, with the synthesizer, it was hard to not acknowledge and admire the idea in itself – the facilitation of the sculpting of sound, while frowning upon how it was used. As a result, one could very well oppose the art while defending the technology.

In art the means are often as (/more) important as (/than) the ends, something that puts the use of technology as one of the major factors contributing to people's perception of an artwork's quality or the genius of the creator. The relationship between artist and work of art has been severely altered by introduction of new technologies which have either minimized the artist's contribution to the final result (the work of art) and/or have changed the processes so fundamentally; making current ways of measuring the quality of a work of art outdated, and calls for reassessment. At the same time there seems to be a consensus that, in general, technology decreases human effort, and in turn replaces the human workforce. Although this is often true, it is a truth with modifications. When photography was catalyzing the demise of the engraver, it is true that engravers lost their jobs, but simultaneously the increasing demand of visual documentation resulted in an altogether bigger demand for 'documenters'. Similarly, the synthesizer did take away the jobs for

many studio musicians during the early 1970s, but it also resulted in an increasing demand for studio engineers. (Pinch & Trocco, 2002, pp.148-49)

With art, this is somewhat different. An easier art does not have unwanted repercussions on artists in the same way. With photography, for instance, this part of photography's easiness was praised by many, because it raised the stakes for artists in other arts, something that in turn 'helped' funnel out mediocre artists. On the other hand, photography's perceived easiness undermined its own potential for being considered an art. Consequently, it was important for photographers to make people aware that photography required a certain amount of skill. Photographers had to enrol people into their technological frame. (Bijker, 1995)

Is technology destroying art because it takes away human intervention? Is people's objection to technology mainly there because technology minimizes people's effort when creating art? And is this objection caused by needing to acknowledge that the artists' blood, sweat and tears were crucial ingredients in the creation or due to the belief that the use of technology prevents and discourage human manipulation and creativity?

Or is it just due to people's resentment for everything new and different, a point that can be justified by thinking of the time that is necessary to make a change in artistic conventions reputable by the people? This seems to be especially important in the early stages of the life of a technology, at this point neither the quality nor intended use of the technology are what they have the chance to later become, validating early (the initial) criticism of the change-reluctant majority.

Such fear can also be justified because usually technology is advancing in such a pace that the updated product doesn't necessarily improve all aspects of the replaced product.

This is part of the reason for the revival of analog synthesizers. (Shapiro, 2000, p.208) Art is not superseded similarly. Earlier works of art can usually still be readily accessed.

An important feature when describing the introduction of new technology (/art) is the novelty factor of new things. Related to notions such as fads, hype, fashion etc. an artifact's initial reception can be based more on the exoticness of the artifact, rather than on its quality or usefulness. This novelty aspect has been very important in both cases I have discussed, because it also means that the artifact was well known and stirred up feelings in a major part of society at some stage of the early years of its conception.

The inventions leading up to what finally had evolved into the (pre-digital) modern camera were for the majority "novelty" technologies, for short lived fun rather than for an extended purpose. In the public's technological frame the camera had one single purpose – to serve their curiosity. The camera obscura was just an amusing device for others than scientists and painters, and the shutter speed decrease resulting in Muybridge's animal locomotion photograph sets was, excluding the before mentioned exception, an interesting new way of seeing animals (and probably for some, naked people.) The synthesizer's precursors share a similar response from the majority of the public. The Theremin, extravagantly played without touching the instrument itself, and producing eerie (sine wave) sounds, was popular in the late 1920s, and for some time after its conception, but after a while the novelty factor wore off and the majority was no longer interested in the instrument. This was to some extent true for the synthesizer itself during the early years of its development. Rock bands wanted to have one (and possibly use it) without even knowing what to do with it or how to play it. This trend eventually disappeared as the new and interesting sound became last year's fad and the musicians acknowledged that apart from making a few weird noises the synthesizer was notoriously hard to play. (Pinch & Trocco, 2002) What made the theremin a (somewhat short lived) novelty attraction might

have also been what caught the attention of both Moog and Kakehashi decades later. Seen in this way the theremin fits well into the category of *liminal entities*, artifacts that draws people's attention top another technological frame. (pp.308-9)

In both cases there was a debate on whether the artifact should be considered a machine or an instrument (or art-tool). When drawing the parallel to the camera it should be easier to see the inappropriateness of this debate. The camera is surely something that can be used for both art and other uses, and would by most people still be considered a machine, even if it is the instrument used for creating art photographs. The one doesn't seclude the other. In the case of the synthesizer this was the core of a trial concerning import tariffs, and by law machines and instruments were distinguished, having different rules set on them. (pp.306-8)

4.1.4. Limitations

The relationship between art and technology is highly intertwined with society. People's opinions and views, laws, and contemporary culture have all proved to be central. I have shown that art and technology develops in a multitude of ways and that although some trends can be asserted, there are many loose ends that would suggest further research. When trying to encompass a theme as immense as the development of art and technology, there are bound to be limitations of the research. I will briefly address a few topics that was in no doubt influential for the development in both cases but which I had to let out to be able to keep some coherence in the case studies and to avoid affected conclusions.[63]

I have disregarded macro political issues. Several economic factors helped making photography successful during the 1850s. The "stable political and economic prosperity

[63] In *Analog Days*, Pinch and Trocco makes a big deal and draws several conclusions around the fact that Wendy (Walter) Carlos was going through a sex change around the time of the release of *S-OB.* (*Analog Days* is the only book I have read on the subject were the authors were denied an interview with the artist…)

enjoyed by both France and Britain" is important, so was the emphasis on technological development and its role in the onward march of civilization. (Frizot, 1998, p.94)

Another important issue is the connection between art (and technology for that matter) and class and its relation to taste. I will give an example from the same timeframe I used in the last paragraph. Although, to an extent, part of the rivalry between industrial states, the international exhibitions of the 1850s and 60s were also a result of the increasing interest by the bourgeois to improve the taste in art. (p.185) In the books *Distinction – A social critique of the judgment of taste* and *Photography – A Middle-brow Art* Bourdieu discusses the differences of taste as a result of social class. The role of taste and class was undoubtedly very relevant in both (but probably especially in the first) cases. (Bourdieu, 1984)(1990)

It is also worth mentioning the role of sheer luck. When Daguerre was experimenting with substances to fix the photographic image, he had a major breakthrough when he accidentally left a plate in a cupboard with a broken thermometer. The mercury vapor proved to be a crucial part of the daguerreotype process. These types of accidental discoveries are often referred to as serendipity. (Roberts,1989)

Finally, I will mention the role of magazines in creating technological frames, both when it comes to technology and art. The role of magazines is especially interesting as they play a big part in enrolling actors into a specific technological frame. (Becker,1984)

Because of the magnitude of possibilities when exploring the important factors behind development, it is inevitable that something will be left out. As a result there are many issues and areas to further pursue and explore to get a fuller understanding of the development of the processes of photography and synthesizing sounds. I have learned that it is crucial to limit oneself when researching a case because it is impossible to open every

black box. Moreover, as if this was not enough, a black box will tend to be a *Chinese* black box; when opening one there will be another one inside.

4.2. SCOT and Art

With the case studies, I tried to use the SCOT toolset interchangeably on art and technology. This was a way to further explore the dichotomy between art and technology. I will in this subsection go through major aspects of SCOT theory and discuss the implication of applying them to art rather than technology.

4.2.1. Interpretable Flexibility

Interpretative flexibility is what initially sprung forward as the one of the factors that would have most to do with the conception of art, and maybe the one where the differences between art and technology would be the biggest. At first glance, art seems to be more prone to interpretation, while technology seems tangible and obdurate, without room for interpretations. I have shown that art can be as static as technology can be dynamic. While interpretable flexibility might be seen as undesirable in technology, with the exception when in regard to path dependencies, interpretable flexibility is crucial for the appreciation of art, as well as harder to grasp because it deals with the elusive concept of taste. Is interpretable flexibility a catalyst for technological change while a stabilizer for art, preventing artistic change? The importance of breaking with the norm (originality) is important for artists. In the art world the developers wants to do what the masses *won't*, while when developing technology the developers wants to do what the masses *want.* Obviously, this is a truth with modifications, and it is constantly undermined by marked forces of the modern consumer culture.

4.2.2. Technological Frames

Throughout the paper, the notion of technological frame has been used as one might use the expression paradigm. It might possibly have been confusing, but it was used in this way to make a point of how the technical aspect of a technological frame is not what is important with the term.

People are prejudiced towards everything, whether they like it or not. Everything you perceive is processed in the brain with reference to something else, and depending on the references (and again *their* references) an elusive "notion" will be created of what is perceived. But there are degrees of relativity, some things should be considered more static and fixed than others. In the world of art, these frames are more explicit than when dealing with technology. Either as aesthetics, although vague but still acknowledged as a concept, or as manifests by (aspiring) groups of artists, the frames are set and known in a more explicit way than dealing with 'pure' technology.

Do some paradigms attain normalcy, because they are closer to an absolute truth? Some parts of aesthetics won't change, because they concern what is physically and universally appealing. Again some parts of technological frames won't change because they are better than others. To say otherwise would imply that nothing is true, and the implications that this demands would not be acknowledged by many people. Diligence is an important virtue in the arts and something that to a certain extent crashes with the notion of aesthetics. If aesthetics was the only judge of a piece of art, then the artists effort should not be worthy of attention. The notion of technological frames is an important part of the SCOT framework. Preconceptions about previous technology lead to certain views on new technology. Similarly, preconceptions about previous art lead to certain views on new art. In art this might be more explicitly acknowledged, but in many ways the origin is the same, it all comes down to bias. In art, aesthetics is important when deciding whether or not

something is to be considered art. On the other hand there has been a tradition of defying the masses. This means that one part of the artistic frame consists of traditions and possibly universal, static characteristics, and the other of originality.

4.2.3. Relevant Social Groups

The relevant social groups in the world of art are more obvious than the ones dealing with technological evolution. Among the seemingly obvious ones we find consumers, art critics and artists – the ones that pay the artist, the ones that tell others what to like and the creators themselves. But these groups will again be influenced by each other as well as external forces such as religious conventions or dogma, level of technological sophistication, and history. Again, all will be subjects to the relevant social group of instrument (as in art-tool) makers. These forces can be seen as jointly being responsible for a cultural paradigm, in the world of art this is quite explicitly defined as aesthetics. As much as a pre requisite for appreciating art should be an initial open-mindedness when approaching a new work of art, or a new art form, this is not the case, especially regarding experts. This may partly be due to the fact that an art aficionado's appreciation of a piece of art will be somewhat exponential to the amount of effort used by the artist to create the piece. If it is something new, the amount of effort will be harder to gauge, thus the appreciation for the piece of art will be less.

4.2.4. Inclusion

Because the relevant social groups of art are so set, the notion of inclusion might be seen as more explicit compared to when referring to groups important for technological development. There is usually a bigger importance in being a part of a culture or certain aspects of a culture, and someone's integrity might be compromised if there is inclusion in several relevant social groups. This can be seen when artists denied their use of the camera

as an asset, even though to themselves the use was seen as legitimate, they would not show the use as it would be considered a breach of the common “beliefs” of the artistic community. In the synthesizer case this was of importance in the way music was institutionalized. Carlos had to repress her feelings of how she wanted music to be at the Colombia Princeton Music Center. She disapproved of the ‘ugly’ music that was normally made there, but was afraid to announce it.

4.2.5. Symmetry

SCOT stresses that technology at the time of its conception might (and presumably will) have different meanings attached to it than it will later have. This in turn supposes that at the time of its conception there was no way of knowing how the future of that technology would be. Following this train of thought, if there were competing technologies at that time, it would be no way of knowing which of the technologies would prevail. Because of this, it is important to include similar technology as well as the technology in focus when analyzing technological development. This is rewarding in the sense that it can give a broader understanding of why a technology prevailed rather than another. Because technological development is non linear, a technology’s popularity does not ensure its legacy. Or to turn it the other way around, a technology’s path of development does not necessarily draw the foundation from what was previously more popular. With photography, the daguerreotype was highly more popular than the calotype; nevertheless, the continuing developments in photography had more in common with the less popular calotype. With the synthesizer, the Telharmonium was a failure but in retrospect it can be viewed as the first synthesizer.

4.2.6. Democratization

Sometimes the relationship between art and technology is a direct one, as when technology enables a type of art (as with the camera), or when art dictates the developments of technology. Other times, probably constantly, art and technology are intertwined in the system of relativity of everything around us; art influencing society, in turn influencing technology, and so on in infinite combinations. Technology, art and society are part of a system, sometimes referred to as the *seamless web*. The seamless web is too complex for anyone to get an overview of, but there are devised ways to grasp at least parts of it. The SCOT theory is such a way. The theory emphasizes the parts of the all encompassing system that has got to do with specific social factors, and by this elucidates *certain* aspects of technological development. Motivated by an idealistic political agenda and with an emphasis on the democratization of technological development it can be seen as much as a political tool, and an increasingly important one as that. (Bijker, 1995)

One of the major goals of SCOT theory is to give an awareness of how power structures – i.e. society – are of utter importance in the innovation process. The theory tries to raise an awareness of the potential power everyone, to a certain extent, has to alter the course of technological progression. Moreover, SCOT theory assumes that most people think of technology as something that develops whether they interfere or not, which is true in the sense that one person's opinion and effort does not change a whole lot. This understanding of technological progress is presumably wrong if you look at it in the way that technology in itself is the only catalyst for further technological change. As I see it, this is related rather to the *tragedy of commons* than to *technological determinism*. The tragedy of commons refers to how people assume that 'if they don't do it, somebody else will'. Another way of seeing this is that if technological development is stopped (or altered) here, the technology can still be further developed somewhere else. This view is reinforced by

Thebérge: “In the competitive and fast-changing world of electronic instruments, most industry experts agree that a period of no longer than two or three years can elapse before a product must be brought to the market.” (Thebérge, 1997, p.51) Another problem of technological determinism, or the strong theory of social construction on the other opposite, is that it is impossible to falsify, or to prove. That is because of a factor that is linear, time itself.

When applying SCOT theory to art, the relevance of the goal is unclear. Is art better off by being governed by as many as possible? It is interesting to note photography’s role in the democratization of visual arts. Not only as an art itself, but in the way photography enabled virtually everyone to view works of art without having to be at the place of the original and without having to pay a potential entrance fee. It is then easy to conclude that it is technology that is responsible for the democratization and to a certain extent that would be right. But as SCOT theory stresses, technology in itself can’t do anything, someone has to distribute and create a market for copies of other works of art.

Is some artists’ resentment towards new technology due to the view that new technology leads to the democratization of art, enabling nearly everyone to produce works of art and thus undermining their own current status? (The lowering/leveling of the pedestal.)

Do artists resent innovation because they know that there are always two sides of the coin, that innovation always enthrall as well as liberate? In *Any Sound You Can Imagine*, Thebérge (1997, p.255) quotes an artist on his remarks about the impact of technology. The artist acknowledges the possibilities technology gives him, but simultaneously complains about the struggle to be up to date. This raises the question of whether art today is too dependant of technology. As we have seen there are two sides of this coin.

Compromising techniques, and products of certain techniques, art is without doubt liable to be analyzed similarly to technology. Also having shown that the different key notions of SCOT theory apply as well, although sometimes requiring minute alterations, one might very well say that (a slightly modified) SCOT framework can be used when analyzing development of art.

4.3. Taxonomy

Whether art and technology are polarized opposites of human creations or whether they are two sides of the same coin is the wrong question to ask. It all depends on the view of the person categorizing. Both art and technology as expressions and in their incarnations are subjects to infinite interpretable flexibility. In this sense I must agree with Francastel who proclaims that "the current antinomy between Art and Technology is a false opposition – one that eventually distorts thinking as well as works of art. An opposition cannot be set up between phenomena that are not of the same nature or, if you prefer, that are always complementary." (Francastel, 2000, p.321)

One of the things that I have found, is that technologies don't necessarily fit into preset categories, in turn making it hard for people to hold on to their (preset) attitudes when confronted with new technology. This is both due to the ever-changing characteristics of (new) technologies, being highly relative in its use, but also the fact that they are a part of the uncharted future, a part of the (possibly) limitless possibilities outside the limited semantics and current epistemology of mankind. The same can be said about art. This is seen in how people are prone to shift "sides" under the course of the progression of a certain technology or art. (E.g. painters/art critics initially and officially despising photography for later to embrace the art – or vice versa.) This might be a result of a relevant social group's

active enrolment of people on the outside of the group, but also due to personal reflection and reassessment of their personal views. What is important here is that the changing of opinion does not have to be a result of explicit display of power. I believe someone can change their mind concerning an artifact because of increased knowledge rather than as a result of the assertion of semiotic power. I also believe someone can change their opinion and appreciation about art and technology without being subjected to external influence. That is not to say that external influence is any less important, most of the time, and for most people it will have much more to say, but it doesn't suffice for the whole part of one's stand. Quality has something to say, which again means that the characteristics of the artifact or work of art (or art form) will prove crucial to the future of the product. I do not say that the SCOT theory does not acknowledge this, but it chooses not to pay much attention to it.

Technology's (perceived) relationship with science, might offer a clue to the autonomy between art and technology. As Eastlake remarked on the use of the collodion process, new technology can be seen as something taking the mystery away from art. People's infatuation with the mystery can be seen as a remnant from the times when works now seen as art, were produced for magical purposes. (Benjamin, 1970) In the book *Unweaving the Rainbow* Richard Dawkins discusses how science is seen as something that takes away the mystery of life because its goal is to give answers to how the world functions. As Dawkins argues, this view is highly personal. (Dawkins, 1998)

Most forms of art has for a long time been dependant on instruments for production. In that sense, the relationship is not necessarily any different today. What I believe, is that the nature of the technology is different, as well as the magnitude of the (socio) technological systems that mediate art. I don't believe this is analogous to earlier 'technological revolutions' and that, to a huge extent, current technology therefore has to be

treated as autonomous entities in the sense that they are automatically put in the technology 'class' and treated as other technology. Needless to say, the same counts for art.

Photography and synthesizing of sound are both technologies that have made it harder to measure whether a product is art or not. This is both because much of the job is automatically processed, making it harder to gauge the work behind, and the fact that new technological frames needs to be developed in order to know what to appreciate.
Brian Eno offers a clarifying remark on this issue: "What has become interesting is the idea that artists are people who specialize in judgment rather than skill." (Quoted in: Thebérge, 1997, p.242)

One might say that new technologies have stretched the limits of what art can be, but I suggest that this relationship will only get stronger. There already exist examples of artificial intelligence creating art[64]. Although still on rudimentary stages, they might offer a clue on what the future might hold.

[64] Examples include a virtual image maker – AARON, the Cybernetic Artist (Website 3) and the music developer 'game' *Elektroplankton* for Nintendo DS.

Figure 13: Picture by AARON (Website 13)

5. Conclusion

I have shown that the development of art can to a certain extent be analogous to the development of technology. Both are subjects to larger changes and factors in the society as whole. I have done this by examining technologies that have a prominent relationship with art. I chose technologies that could be viewed both as art and technology to further make a point about the relationship these two have. Because I wanted to look at the social aspects that were responsible for the dichotomy between the two, I chose to use the SCOT framework for the analysis of the cases. Even though SCOT theory, as its name suggests, deals with the social construction of technology, I wanted to try out whether the toolset the theory provides would work for analysing art as well. This was a way to further explore the relationship between art and technology.

In the first case study I looked at the development of photography. The development of the technology did in several occasions dictate how it could be used as art. It was also important how people had to get used to the new photographic aesthetic.

I went on to explore the process of synthesizing sounds. I showed that it was in part related to earlier musicians' desertedness over contemporary music and also related to several technological developments that worked on different levels throughout the process.

In the previous chapter I discussed how the two cases shared similar tendencies, both regarding art and technology. Among several findings I mentioned how art has become more and more democratized, both in the possibilities of producers and consumers. I continued with discussing whether SCOT theory could be applied to art development or not. The conclusion was that most of the SCOT framework worked very well with art, with a few cosmetic modifications. Nevertheless, I made a point of noting how it was less

meaningful to use the framework for art rather than technology, because art constituted a human fabrication that was in no urgent need of democratization. This conclusion was made after having argued that SCOT's purpose is not to tell the complete story behind development, but rather to stress certain aspects of development that have been neglected in previous research. The reason for this is to convey a better understanding of how people matter in the development of technology, and ultimately to democratize technological development.

The two case studies have provided a better understanding on how art and technology might develop, but they have also raised questions for further research. Art and technology are part of a complex system. To use a SCOT term, the terms art and technology are both as notions and in their manifestations still very much subjects to *interpretable flexibility*.

References

Litterature:

Allen, R. E. (Ed.). (1984). The Pocket Oxford Dictionary of current English. Oxford: Clarendon press.

Arago, D. F. (1980). Report. In Trachtenberg, A. *Classic essays on photography* (pp.15-26). New Haven, Connecticut: Leete's Island Books. (Published in Eder, J. M. (1945). *History of Photography*. New York: Columbia University Press)

Batchen, G. (1997). *Burning with desire: the conception of photography*. Cambridge, Massachusetts: MIT Press.

Becker, H. (1984). *Art Worlds.* Berkeley, California : University of California Press

Benjamin, W. (1970). The Work of Art in the Age of Mechanical Reproduction in *Illuminations* (pp.219-53). London: Cape.

Bijker W. E. & Law J. (Eds). (1992). *Shaping technology/building society: studies in sociotechnical change*. Cambridge, Massachusetts: MIT Press

Bijker, W. E. (1995). *Of Bicycles, Bakelites, and Bulbs.* Cambridge, Massachusetts: MIT Press.

Bijker, W. E. et al (Eds.). (1987) *The Social construction of technological systems: new directions in the sociology and history of technology*. Cambridge, Massachusetts: MIT Press

Bourdieu, P. (1984). *Distinction: a social critique of the judgement of taste*. Cambridge, Massachusetts: Harvard University Press. (Original work published in 1979)

Bourdieu, P. (1990). *Photography : a middle-brow art*. Oxford: Polity Press. (Original work published in 1965)

Daguerre, L. J. M. (1971). *An historical & descriptive account of the various processes of the daguerreotype & the diorama*. New York: Hexagon International.(Original work published in 1839)

Daguerre, L. J. M. (1980). Daguerreotype. In Trachtenberg, A. (1980). *Classic essays on photography* (pp. 11-14). New Haven, Connecticut: Leete's Island Books. (Original work published in 1839)

Dawkins, R. (1998). *Unweaving the rainbow*. New York: Houghton Mifflin Company.

Eastlake, E. (1980). Photography. In Trachtenberg, A. (1980). *Classic essays on photography* (pp. 39-68). New Haven, Connecticut: Leete's Island Books. (Original work published in 1857)

Fagerberg, J. et al (Eds.). (2005). *The Oxford handbook of innovation.* Oxford: Oxford University Press

Francastel, P.(2000). *Art & technology in the nineteenth and twentieth centuries.* New York: Zone Books; Cambridge, Massachusetts: The MIT Press. (Original work published in 1956)

Frizot, M. (Ed.). (1998). *A new history of photography*. Köln: Könemann. (Original work published in 1994)

Green-Lewis, J. (1996) *Framing the Victorians: photography and the culture of realism.* Ithaca: Cornell University Press.

Holmes, T. (2002). *Electronic and experimental music: pioneers in technology and composition*. New York: Routledge. (Original work published in 1985)

Kakehashi, I. (2002). *I believe in music*. Milwaukee: Hal Leonard Corporation.

Kracauer, S. (1980). Photography. In Trachtenberg, A. *Classic essays on photography* (pp. 245-268). New Haven, Connecticut: Leete's Island Books. (Original work published in 1960)

MacKenzie, D. & Wajcman, J. (Eds.). (1985). *The Social shaping of technology.* Milton Keynes : Open University Press

McLuhan, M. (2001). *Understanding media*. New York: Routledge. (Original work published in 1964)

Newhall, B. (1971). An introduction. In Daguerre, L. J. M. *An historical & descriptive account of the various processes of the daguerreotype & the diorama*. New York: Hexagon International.(Original work published in 1839)

Niepce, J.N. (1980). Memoire on the Heliograph. In Trachtenberg, A. *Classic essays on photography* (pp. 5-10). New Haven, Connecticut: Leete's Island Books. (Published in Eder, J. M. (1945). *History of Photography*. New York: Columbia University Press)

Pinch, T. & Trocco, F. (2002). *Analog days: the invention and impact of the moog synthesizer*. Cambridge, Massachusetts: Harvard University Press.

Roberts, R. M. (1989). *Serendipity: accidental discoveries in science*. New York: John Wiley.

Scharf, A. (1983). *Art and photography*. Harmondsworth: Penguin books. (Original work published in 1968)

Shapiro, P. (Ed.). (2000). *Modulations: a history of electronic music: throbbing words on sound*. New York: Caipirinha Prod.

Singh, S. (2004). *Big Bang: The Origin Of The Universe.* New York: HarperCollins Publishers Inc.

Tagg, J. (1988). *The burden of representation: essays on photographs and histories.* Basingstoke: Macmillan Education.

Talbot, W.H.F. (1980). A Brief Historical Sketch of the Invention of the Art. In Trachtenberg, A. *Classic essays on photography* (pp. 27-36). New Haven, Connecticut: Leete's Island Books. (Original work published in 1844-46)

Théberge, P. (1997). *Any sound you can imagine: making music/consuming technology*. Hanover, New Hampshire: Wesleyan University Press.

Trachtenberg, A. (1980). *Classic essays on photography*. New Haven, Connecticut: Leete's Island Books.

Van Dulken, S. (2002). *Inventing the 20th century*. London: The British Library

Williams, R. (1987). *Culture and society: Coleridge to Orwell*. London: Hogarth. (Original work published in 1958)

Websites:

Website 1: http://www.kodak.com/US/en/corp/kodakHistory/1878_1929.shtml

Website 2: http://www.rleggat.com/photohistory/

Website 3: http://www.kurzweilcyberart.com/

Website 4: http://www.collodion-artist.com/Schedule/will_cam2.jpg

Website 5: http://www.foto-faq.de/images/pic-gesch/niepce.jpg

Website 6: http://www.edwardsamuels.com/illustratedstory/chapter%206/Eastman.jpg

Website 7: http://www.nga.gov/feature/artnation/cameron/images/cameron/cameron_oaktree_362x400.jpg

Website 8: http://www.137.com/theremin/leon_theremin300c.jpg

Website 9: http://www.aliens-project.de/bilder/walhalla/Moog+Buchla.jpg

Website 10: http://www.rpi.edu/~turcoj/Timeline/Art%20History/1913-russolo-intonarumori.jpg

Website 11: http://netninja.com/images/lj/wendy_carlos-moog.jpg

Website 12: http://www.notam02.no/~joranru/MekMusikk/schaeffer.GIF

Website 13: http://www.stanford.edu/group/SHR/4-2/text/cohen.html

Documentary:

Fjellestad, H. (2004). *Moog.* USA